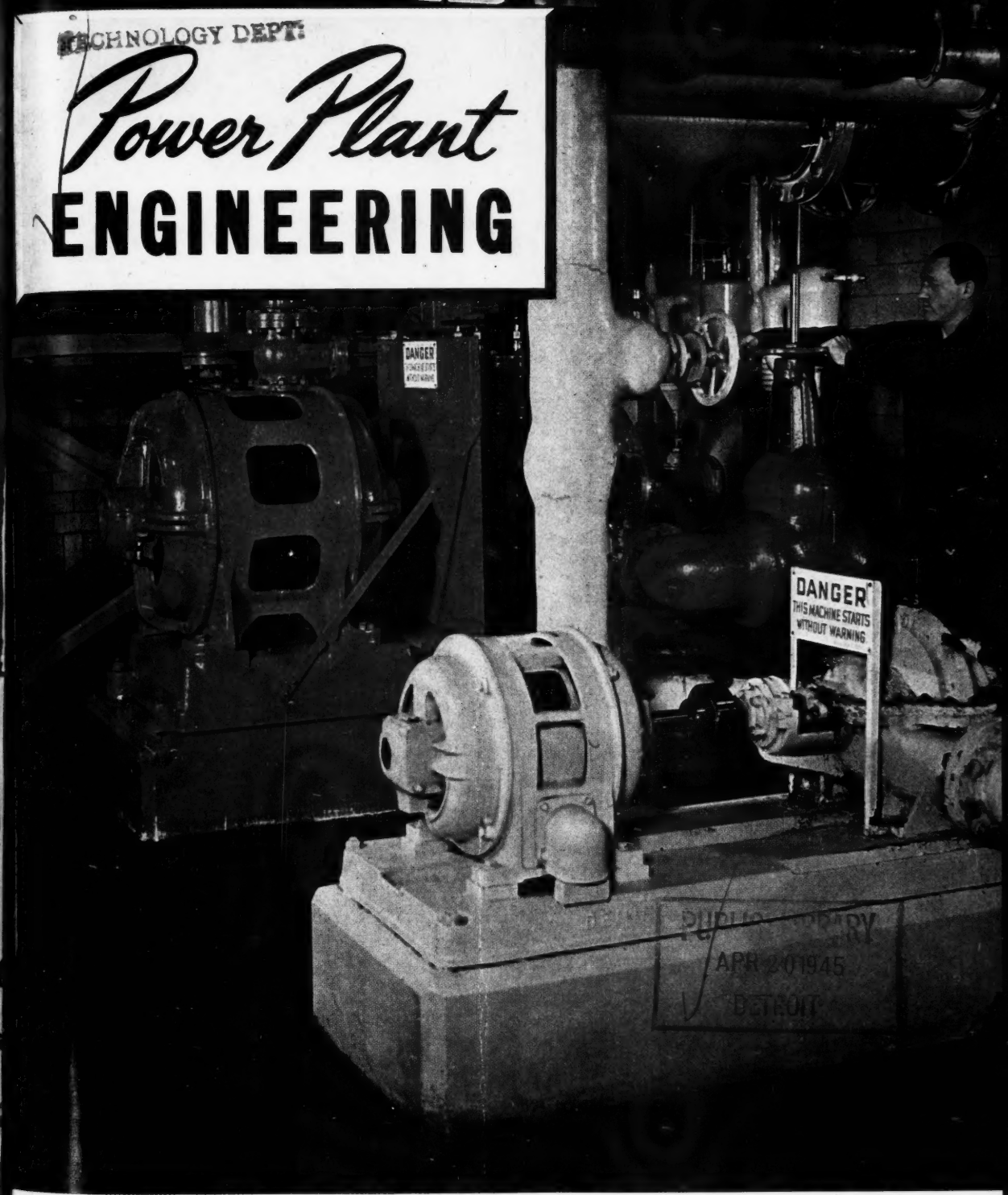
TECHNOLOGY DEPT.

Power Plant ENGINEERING



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THE POWER ENGINEERING AND MAINTENANCE MAGAZINE FOR EVERY INDUSTRY

APRIL 1945

Features

GRAND COULEE SETS THE PACE • MODERN EXTRACTION TURBINES — PART 4 • CENTRAL STATION AUXILIARIES • THE MEANING AND USE OF ENTROPY • ADDITIONAL CAPACITY FOR BOONE STATION

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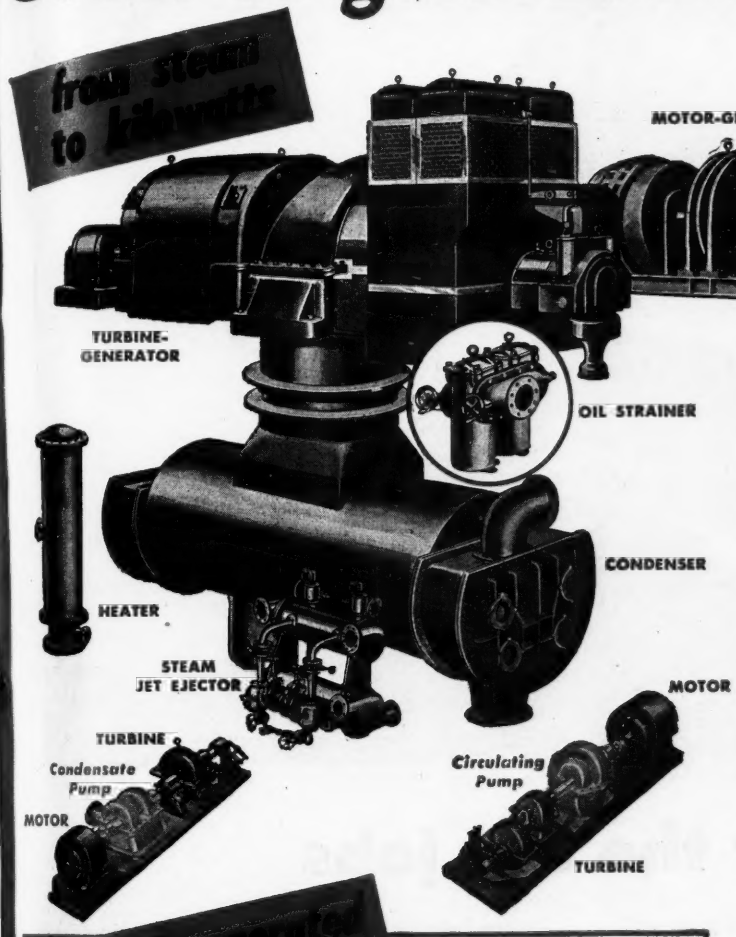
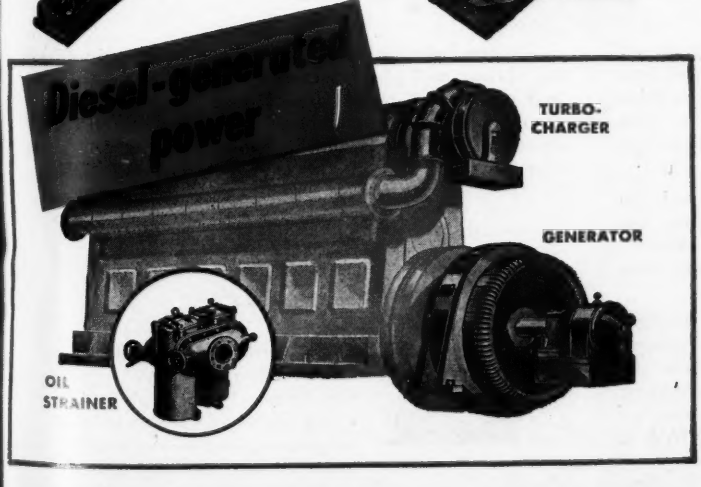
ELLIOTT -- from boiler f

ELLIOTT

feed to generated power





On these two pages we picturize the varied equipment essential to put power-on-the-line. There's a lot of it — and a surprisingly large number of these units, (shown in full tone) is being built by Elliott Company.

Some of this equipment, the smaller units particularly, is pretty well standardized, being built on Elliott designs developed through years of practical service. Some, however, such as turbines, generators, larger motors, etc., are designed and built for the specific conditions under which they must operate. How well these conditions are met is attested by the confidence of power plant engineers in equipment with the Elliott mark.

There is nothing dramatic about dependable operation. But there *is* continuous and predetermined profit. That is the element which dominates in all Elliott equipment.

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Power Plant ENGINEERING

April 1945

VOLUME 49 — NUMBER 4

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Front Lines

OF THE 600 FIGURES carved on the big Riverside Drive church in New York City, the only living man represented is Albert Einstein, in many respects the world's greatest living scientist. So comments Rufus Oldenburger in the Chicago Sun in calling attention to a new book about this great man. The new book is called simply Einstein, by Dimitri Marianoff and Palma Wayne. Mr. Marianoff is Mr. Einstein's son-in-law, hence is able to give a picture of Einstein the man as well as of Einstein the scientist. His name, of course, means nothing to 99 per cent of our population. Those who know it scarcely need to be reminded that he got out of Germany only a few jumps ahead of the Nazis who had put a price of $5000 on his head. Einstein said he did not know it was worth so much. When asked at what salary he would come to the Institute for Advanced Study at Princeton, N. J., Einstein mentioned such a low figure that the trustees insisted he accept four times as much. Everybody who knows him seems to agree that he is a truly remarkable character, a man of utter simplicity, with very little feeling for money or material possessions and a fervent and almost religious adherence to the truth. That he is also intensely human is shown by his love for the music of Bach, for sailing boats, old pipes and playing his violin. It would be presumptuous of us to catalog or evaluate his contributions to science but the book referred to above gives a great deal of this information. It is not too much to hope that future generations, as they learn how to apply science for the welfare of man instead of for his destruction, will see in Mr. Einstein a figure far more important and interesting than those of the great conquerors and destroyers that have been worshipped for so long.

A VERY DISRESPECTFUL NOTE is beginning to creep into our postwar planning. Every business man in the country, someone has said, has two postwar ambitions: 1, To use plastics in his present products; 2, To get into some other business. Every once in a while somebody throws a bucket of very cold water over the postwar planners by reminding them that a great many of the materials they are now using, and with which they have done such wonders in war production, are merely substitutes for the critical metals they could not get. What will happen, ask these cold-water-throwers, when it is finally possible to consider making anything you desire from steel, or from various alloys or other metals now unobtainable? What effect will that have on design and on production methods? Don't forget, continue the cold-water-throwers, that a great deal of the equipment you are now manufacturing of plastics and light metals is definitely intended to be expendable in war to attain a military objective, with considerations of light weight always in mind but with little consideration for initial cost and maintenance cost.

IF YOU HAVE BEEN WONDERING whether or not the electron microscope would help you in your business, whether it was too complicated to be used by any but the most highly trained scientists and how much it would cost, you may be interested in the new book entitled Seeing the Invisible—The Story of the Electron Microscope, by G. G. Hawley recently published by Alfred A. Knopf, New York City, price $2.50. This book describes the device clearly and discusses its advantages and disadvantages.

AS THE RESULT of a nation-wide consumer and industry survey of postwar needs, the United States Chamber of Commerce has recently issued its Third Progress Report. According to this report, 13,755,000 families intend to buy one or more major household appliances, the total valued at approximately $1,215,910,000, as soon as they can be obtained. This figure does not include any electric appliances bought for commercial use or as normal equipment for apartments, neither does it include the export market. It represents, however, the domestic consumer buying intention within six months after Victory. According to the Wesco Dealer's Profit Guide, intended purchases of seven products are somewhat as follows: Refrigerators, 2,625,000 families; Washing Machines, 2,100,000 families; Ranges, 1,645,000 families; Vacuum Cleaners, 1,400,000 families; Radios, 2,555,000 families; Sewing Machines, 840,000 families; and Electric Irons, 1,505,000 families.

KITTEN CRACKER would seem to be the logical term to give a small size version of a Cat Cracker, so logically that is the name given to it by Universal Oil Products Co. of Chicago, in announcing its recent development. The Cat Cracker, as everybody must know by this time, is the name for the Catalytic Cracking Unit employed in petroleum refining and the larger U. O. P. Cat Crackers have charging capacities from 2,600 to 16,000 barrels. The new Kitten Cracker designed for a 1,500 barrel capacity, embodies all the technique and experience resulting from operation of the larger units.

Why Your March Issue Was Late

WE'VE SUCCESSFULLY weathered a printing crisis. Here's the story.

Until the March issue every copy of **POWER PLANT ENGINEERING** published since 1908 had been printed by Excelsior Printing Co. Excelsior acquired new ownership and management about four years ago as a result of the death of the former owner. For three years things went along smoothly. Then about a year ago we became suspicious that all was not well with the new management. So we began negotiations with other large printing concerns; but in these days it is difficult to find a printer, with sufficient equipment and manpower to handle a publication job as large as **POWER PLANT ENGINEERING**, who is not overloaded with work.

In January of this year, Excelsior Printing Co. confirmed our earlier suspicions by suddenly going into bankruptcy. The equipment was sold piecemeal and February **POWER PLANT ENGINEERING** was printed under extremely difficult circumstances. Fortunately right at this stage our long-hoped-for arrangement was completed with Blakely Printing Co. of Chicago, which took over beginning with the March issue.

Changing printers is a complicated operation at best and in these days the problems are multiplied a hundred fold. But Blakely is one of the best-managed and highest-quality printing concerns in the land and through splendid teamwork March issue was published with the same high quality workmanship you expect in **POWER PLANT ENGINEERING.** You will note in the April issue that we are changing the body type face. The new type is more easily read but takes no more space, so this is one important improvement from the new printer.

The March issue was late, which we like even less than you do. We appreciate the patience and understanding of our readers and advertisers during this crisis and assure you that we will be able to work our mailing date back to normal in another month or two.

INFRA-RED lamps are being utilized to solve parking and garage problems, it was reported recently to the SAE, by Robert H. Dalgleish, Jr. assistant superintendent of rolling stock and shops for the Philadelphia Transportation Co. To take care of wartime traffic increases, his company's fleets have been increased in locations where adequate storage is not available. Hence, greater attention had to be given to the problem of outdoor storage of buses and their adequate protection under these conditions. The success of infra-red heating in industrial applications pointed to this means of heating as a possible solution for the problem. Preliminary installation was made to accommodate 27 buses. Parking berths were laid out and small pits at these berths were equipped with four 250-watt infra-red lamps each, controlled by a simple fuse switch circuit panel board with switch and meter equipment in a small weatherproof wooden house. All lamp-pits were constructed of creosoted wood, and spaced so the bus engines would receive the heat from the lamps. One season has been completed with the use of infra-red heat and no starting difficulties were encountered throughout that period in which there were fifty days below 20 F and temperatures were as low as 2 F. In fact the engines started better and required less checking than those stored in garages where temperatures averaged 35 to 40 F., according to Mr. Dalgleish as reported in the New York Times. He estimates that about 5000 gallons of gasoline were saved in this operation by not having to idle the engines and about 5000 engine operating hours.

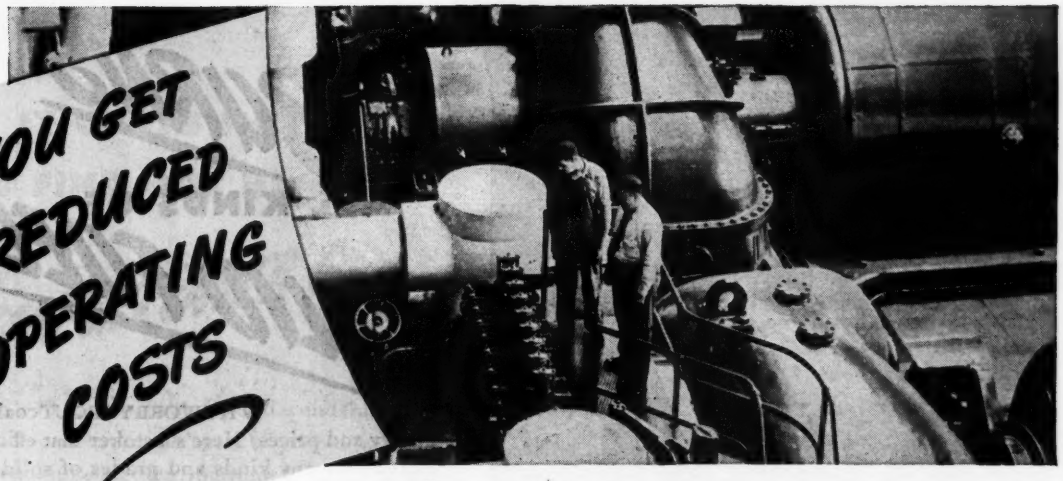
SPALLING RESISTANCE of 50 brands of fire-clay brick have recently been investigated by R. A. Heindl and W. L. Pendergast of the National Bureau of Standards, employing the standard test method of the ASTM. This method involves the conditioning of a panel of brick specimens by preheating to either 2900 F or 3000 F, and after cooling, subjecting it to 12 cycles of 20 minutes' duration of alternate heating to 2550 F and then cooling by an air-water mist. Variations from the standard panel of brick were made by laying brick as headers only, and in combinations of headers and stretchers. These represent the different types of construction used in furnace linings. Although there were exceptions, most firebrick showed greater losses in header construction than in stretcher, but in some cases the type of construction had little effect. It was also found that in general a relation exists between the pressure maintained in the furnace during the preheating of the brick and their resistance to spalling. The results of this investigation, which are given in full in the January Journal of Research, will be used as a basis for the technical requirements in a proposed revision of the current Federal Specification HH-B-671 for Fire-Clay Brick.

TUNG OIL is not, as you may have thought, a gargle for vacuum cleaner salesmen and politicians. On the contrary, it has for many years been one of the vital ingredients in high-grade paint and varnishes and a number of other protective coatings. It is extracted from the kernels of the nuts of the tung or China wood tree and until relatively recent years has been imported from China. A few years ago, however, the first tentative plantings of tung oil trees were made in this country and there is now in the state of Louisiana the beginnings of a very prosperous tung oil industry. For a complete and very interesting illustrated account of this entire development see the article Ancient Tung Oil Aids Modern Science by Lillian King Markland in the February, 1945 issue of the Central Manufacturing District magazine, 38 South Dearborn St., Chicago 3, Ill.

ESTABLISHMENT OF A new board of military and civilian scientists to develop weapons for any future conflict has just been announced, according to the New York Times. To be known as the Research Board for National Security, the panel will serve in the interim between the expiration of the present office of Scientific Research and Development, a wartime agency, and the establishment by Congress of an independent agency to carry on the work. The new board has been set up by Dr. Frank B. Jewett, president of the National Academy of Sciences, at the request of the Armed Services. In explaining why the board was needed, Secretary of War Stimson and Secretary of the Navy Forrestal said, "This war emphasizes three facts of supreme importance to national security: 1, Powerful new tactics of defense and offense are developed around new weapons created by scientific and engineering research. 2, The competitive time element in developing those weapons and tactics may be decisive. 3, War is increasingly total war, in which the armed services must be supplemented by active participation of every element of civilian population. To secure and insure continued preparedness along far-sighted technical lines, the research scientists of the country must be called upon to continue in peacetime some substantial portion of those contributions to national security which they have made so effectively during the stress of the present war." The executive committee is headed by Karl Compton, president of MIT, as chairman. Other members are Roger Adams, University of Illinois, Department of Chemistry; A. H. Dochez, Columbia University College of Physicians and Surgeons; Brig. Gen. W. A. Borden, War Department, special staff and director of new developments division; Rear Admiral J. A. Furor, coordinator of research and development, Navy Department. There has been such a universal feeling in the country that something of this sort ought to be done, that we hope you will join us now in three loud, lusty cheers.

PLAN NOW FOR STORAGE of War Machines is the title of an interesting discussion of a subject vital to many manufacturers, given in the January, 1945 issue of Production Data from the Houghton Line, published by E. F. Houghton & Co., 303 W. Lehigh Avenue, Philadelphia 33, Pa.

"WE HAVE NEVER been a nation of faggot-pickers. The conviction that our natural resources were inexhaustible has shaped our economy. At once the wonder and the scandal of the world, our industrial practices have always been wasteful. We did not bother with inferior stuff. We took the best and went on. Wasn't there plenty more where that came from? Today the signs are many that America's traditional plenty, while by no means worn out, is fraying about the edges. Unparalleled demands for war have gouged our mines, oil wells, and forests. Industry thinks of going in for faggot-picking, after all. But it will be faggot-picking on the typically American grand scale. Thanks to advanced technology, the mounds of rubbish cast off by industry can become profitable raw materials. Postwar horizons cites an outstanding example: the wealth latent in sawing refuse, long the No. 1 disposal problem in lumbering. Through the magic of chemistry, the nation's sawdust heaps can sustain new industries, with products ranging from ethyl alcohol (identical with alcohol made from grain), motor fuels, and cattle feeds to plastics, dyes, drugs, and flavors." The foregoing is the introduction to a detailed discussion of how this can be done, given under the subject of Postwar Horizons in Newsweek, February 12, 1945.



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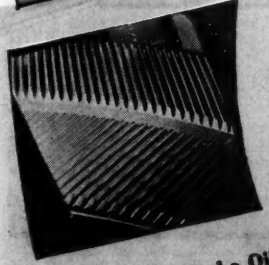

2 When Shell Turbo Oil is used . . . following Shell Turbine Cleaning Procedure . . . gears remain clean and peak efficiency results.

YOU WIN from the start when you follow the new Shell Turbine Cleaning Procedure. It has been scientifically developed to assure thoroughness; at the same time, it simplifies and speeds each step from "Stop" to "Start."

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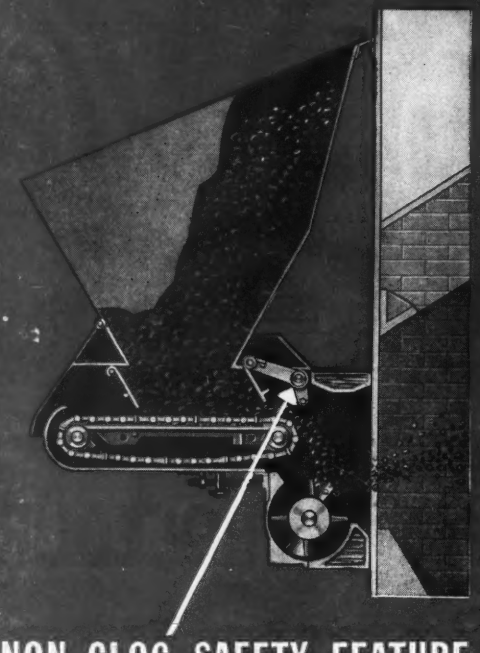

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It's the Æ Perfect Spread Stoker, a compact, completely automatic fuel-firing unit for high or lowest grade coals, coke breeze or sawdust. You can even burn corn cobs, hogged fuel, wood refuse, plant refuse and by-products for still greater economy.

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If Your Steam Requirements Call for 175 H. P. up to 200,000 lbs. per hour—

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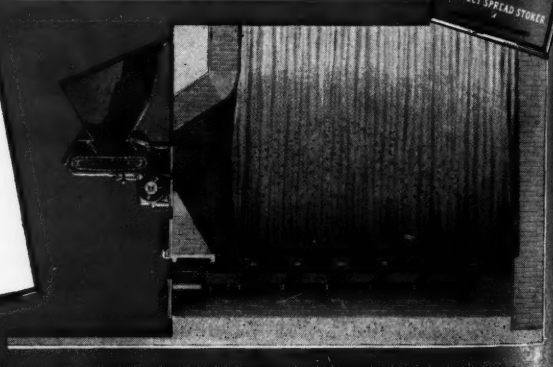

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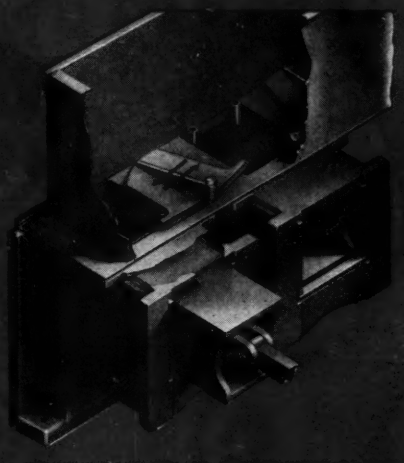
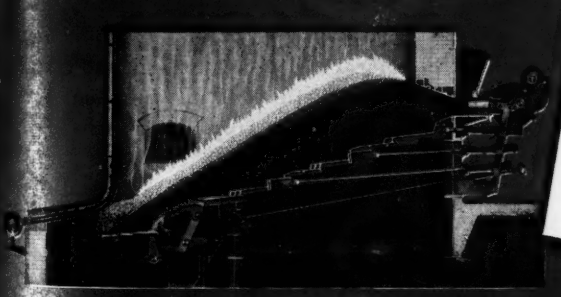


AGITATOR PREVENTS B-R-I-D-G-I-N-G IN COAL HOPPER

Wet or partially frozen coal is prevented from packing and "bridging" in the stoker hopper by unique agitators. Operated by alternating strokes of the coal rams, a series of oscillating agitators located between the rams prevents bridging and keeps coal flowing. Each coal ram gets a *full* charge every stroke and a uniform fuel bed is maintained.



Æ TAYLOR STOKERS

AIR-COOLED & WATER-COOLED

AMERICAN ENGINEERING COMPANY

PHILADELPHIA 25, PA

COMPACT, self-contained G-E unit substations are "strong points" of modern power distribution

It seems incredible. But the fact is that each of the two factory-built G-E unit substations you see above handle one-third *more* power than the entire conventional (gingerbread) layout at the top of the opposite page. They do it with lower electrical losses, and afford greater protection for personnel. Installed as a part of a well-planned, modern power-distribution *system,* they help to assure greater continuity of power to every point of use.

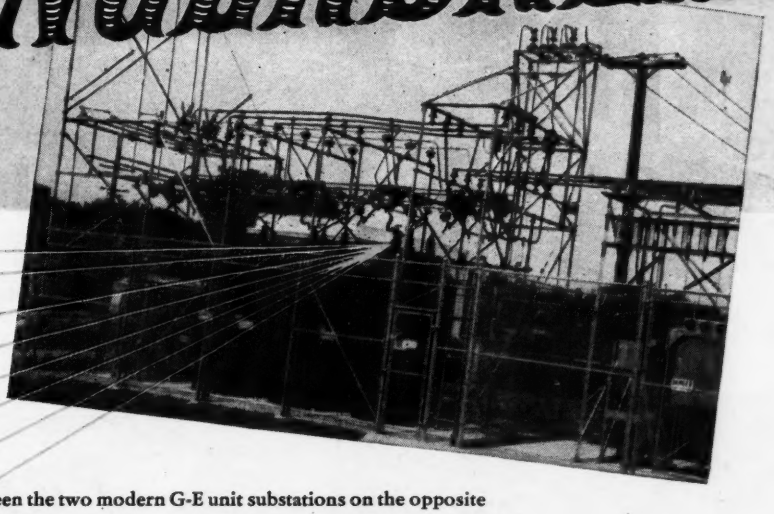
G-E unit substations practically eliminate the manpower problems of assembly on the job. They come ready to connect, combining the necessary transforming capacity, cable-termination facilities, and high-voltage and low-voltage switchgear. The transformer section of each unit is sealed against dirt and dampness. With Pyranol*, which can't burn, these substations can go anywhere, outside or indoors. The metal-clad switchgear isolates each circuit and circuit breaker in a separate, grounded compartment. Vertical-lift breakers have interrupting capacity fully adequate for any emergency.

A plant power system that combines several unit substations close to the load centers is highly flexible. Increased loads can be met, step by step, with duplicate units. And war-plant records of "unit subs" in service show unusual savings in maintenance and man-hours. Ask your G-E representative for the story. *General Electric Company, Schenectady 5, New York.*

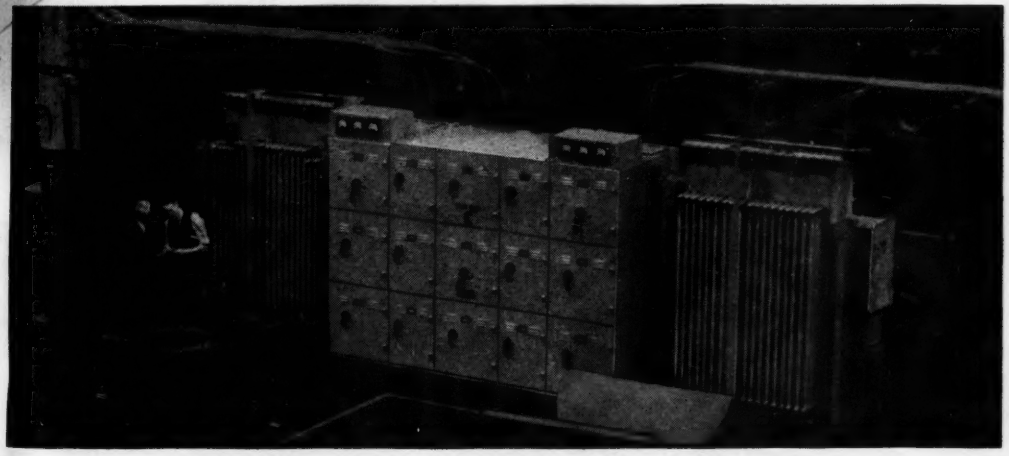
*Trade-mark Reg. U.S. Pat. Off.

Buy all the BONDS you can—*and keep all you buy*

to GINGERBREAD



WHAT A CONTRAST between the two modern G-E unit substations on the opposite page, which serve nine 300-hp pump motors, and the layout above, which serves only three 500-hp pump motors. Yet even the gingerbread substation above affords better protection than many old-time "briar-patch" installations still in service.

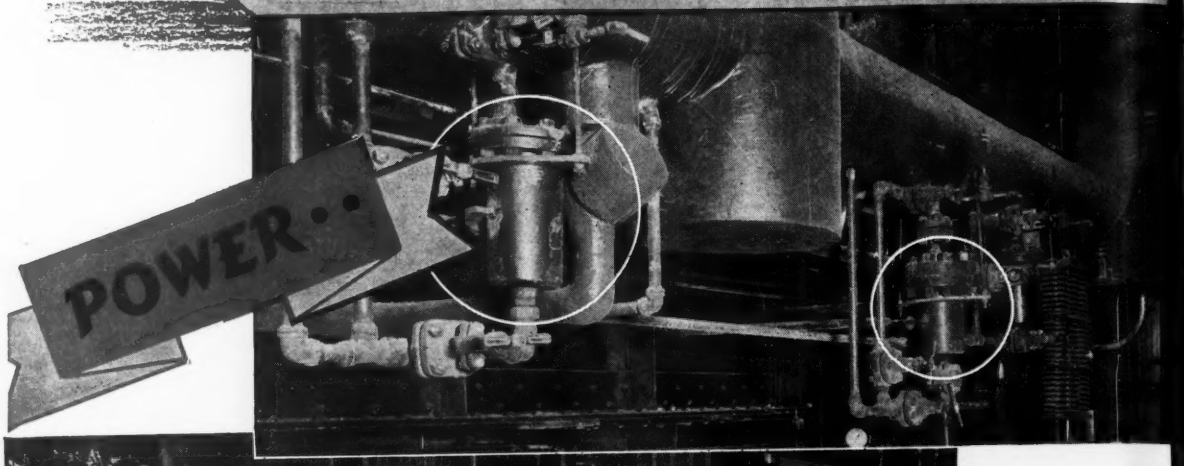


INDOORS, EVEN MORE ADVANTAGES are made possible by G-E unit substations combined in a co-ordinated, load-center distribution system. They can be placed in factory work-areas, thus keeping short the heavy-copper secondary circuits, and overcoming voltage-drop problems economically. Unlike open switchboards and oil-cooled transformers, they need no isolation wards indoors.

LOAD-CENTER POWER DISTRIBUTION SYSTEMS

GENERAL ELECTRIC

SOME AIDS TO THE S



ARMSTRONG STEAM TRAP

ARMSTRONG *Inverted Bucke*

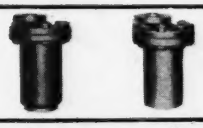
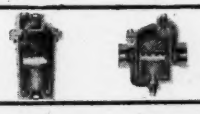
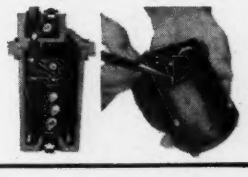
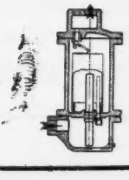
Selection of STEAM TRAPS

In planning the installation of steam traps, it is desirable to have in mind the types of traps available for various services. The chart below, describing briefly the Armstrong Traps available to meet practically any condensate requirements, will serve as a guide.

For complete data, capacity charts, prices, selection procedures, etc., send for your copy of the ARMSTRONG STEAM TRAP BOOK.

ARMSTRONG MACHINE WORKS
810 Maple Street • Three Rivers, Michigan

SAVE COAL!
Keep your traps in good repair. Ask for bulletin on trap inspection and repair.

SERVICE	TYPE OF TRAP	
1. HIGH PRESSURE or where all steel fittings are desired. (Up to 2400 P.S.I.)	Armstrong Inverted Bucket Steam Trap with FORGED STEEL body and cap. Screwed or flanged connections.	
2. MEDIUM PRESSURE — coils, kettles, headers, etc. (Up to 250 P.S.I.)	Armsrong Inverted Bucket Trap with cast semi-steel body and cap and same stainless steel mechanism used in forged steel traps. Side-inlet side-outlet or bottom-inlet top-outlet connections.	
3. LOW PRESSURE—unit heaters, coils, etc. (From 1 P.S.I. up.)	Identically the same traps, except for part sizes, as No. 2 above!	
4. WHERE LARGE AMOUNTS OF AIR MUST BE HANDLED —such as on "up-and-down" process units and low pressure heating systems. (Pressures to 250 lbs.)	Armstrong Inverted Bucket BLAST TRAPS capable of handling 500 to 1500 cu. ft. of free air per hour, depending upon bucket size.	
5. WHERE EXCESSIVE AMOUNTS OF CONDENSATE MUST BE HANDLED—steam separators, purifiers, hot water heaters, etc. (Pressures to 900 P.S.I.)	Armstrong PISTON OPERATED Compound Traps with capacities up to 300,000 lbs. of condensate per hour.	
6. WHERE PULSATING PRESSURES ARE ENCOUNTERED such as caused by reciprocating engines and pumps. (Pressures to 600 P.S.I.)	Armstrong Inverted Bucket Traps with special separating chambers.	

STEAM TRAPS for POWER PROCESS HEATING

Specify Republi

A Republic combustion control system operates the three boilers in this new power plant which supplies all the steam and power for a large university. During the first year of operation this new plant provided heat for
percent more building space, generated 114.3 per
more electric power but consumed 9.86 percent less

REPUBLIC
INSTRUMENTS
AND CONTROLS

Combustion Control

TO INCREASE TODAY'S STEAM PRODUCTION

TO DECREASE TOMORROW'S STEAM COST

The installation of Republic automatic controls on your boiler (or boilers) will enable you to:—

SAVE FUEL by automatically maintaining highest combustion efficiency.

INCREASE STEAM OUTPUT by operating the boilers at test efficiency 24 hr. a day, 7 days a week.

CONSERVE MANPOWER by automatically performing the many routine repetitive adjustments.

REDUCE OUTAGES by maintaining uniform operating conditions and thereby prevent the chain-of-event type of trouble that frequently developes as a result of incorrect boiler operation.

An automatic combustion control system, as designed and built by Republic, will help you meet today's need for more steam and tomorrow's need for lower steam costs.

The Republic combustion control is a unified system controlling simultaneously, in measured quantities and in correct proportions, the fuel and air input to the boiler. It increases or decreases the fuel and air supply to the boiler in the correct amount to maintain constant steam pressure and in the correct ratio to maintain maximum combustion efficiency. It not only checks operation but automatically makes necessary corrections of individual factors before faulty operation has a chance to develop.

The difference between such a control and an assembly of uncoordinated regulating devices is comparatively small in equipment but great in principle. Merely to provide automatic operation of a number of individual device is not enough.

CHECK THESE FEATURES

Built into the Republic combustion control systems are many features that enable it to fulfill all the conditions of theoretically perfect combustion control and still meet all the demands of everyday operation.

Check the following features against your list of "musts" for a perfect combustion control system.

CENTRALIZED CONTROL: The operation and control of the boiler or boilers is centralized at the master controller.

FUEL-AIR RATIO INDICATOR: The master controller is provided with mercury manometers which indicate the measured fuel and air inputs to the boiler and the fuel-air ratio.

FUEL-AIR RATIO ADJUSTMENT: A handwheel on the front of the master control panel provides a convenient means for adjusting the fuel-air ratio.

ALL BOILER RATINGS: Maintains proper fuel-air ratio over the entire range of boiler ratings.

CONSTANT STEAM PRESSURE: Maintains the plant steam pressure within narrow limits of variation by proportioning the fuel and air inputs to the load.

LOAD DISTRIBUTION: Provides a means of distributing the load among the boilers as desired.

MANUAL CONTROL: Boiler ratings can be controlled manually by a handwheel located on the front of the panel.

Find out about Republic control systems. One of our engineers will be glad to consult with you at any time. Write us today.

Republic Flow Meters Co.

2224 Diversey Parkway • Chicago 47, Illinois

TERRY

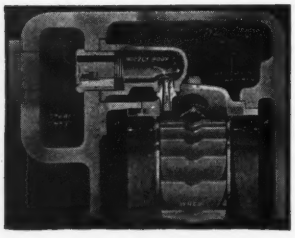
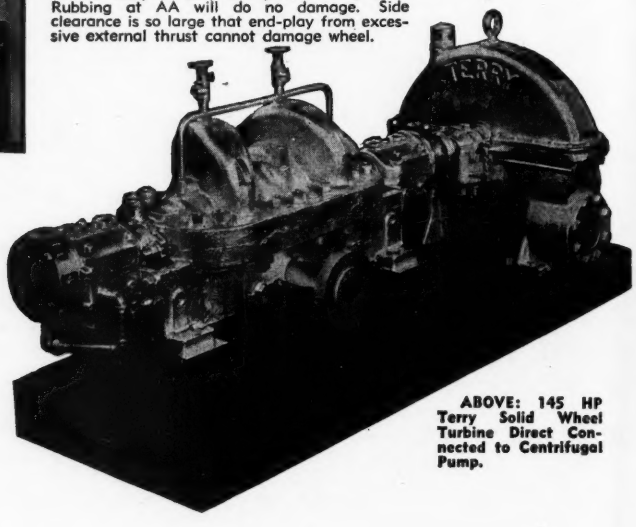


DIAGRAM SHOWING WHEEL CLEARANCES.
AA—Rim clearance, B—Large blade clearance, CC—Side clearance, (about one inch). Blades cannot foul, as they are protected by rims. Rubbing at AA will do no damage. Side clearance is so large that end-play from excessive external thrust cannot damage wheel.



ABOVE: 145 HP Terry Solid Wheel Turbine Direct Connected to Centrifugal Pump.

THESE LARGE WHEEL CLEARANCES INCREASE TERRY TURBINE DEPENDABILITY

In the Terry Wheel Turbine fine blade clearance is not essential to high operating efficiency. The actual clearance between the moving and stationary blades is greater than ⅛ inch. End play cannot affect this clearance and the side clearance is one inch or more. It is therefore not essential to make frequent adjustments of the thrust to maintain efficient and safe operation.

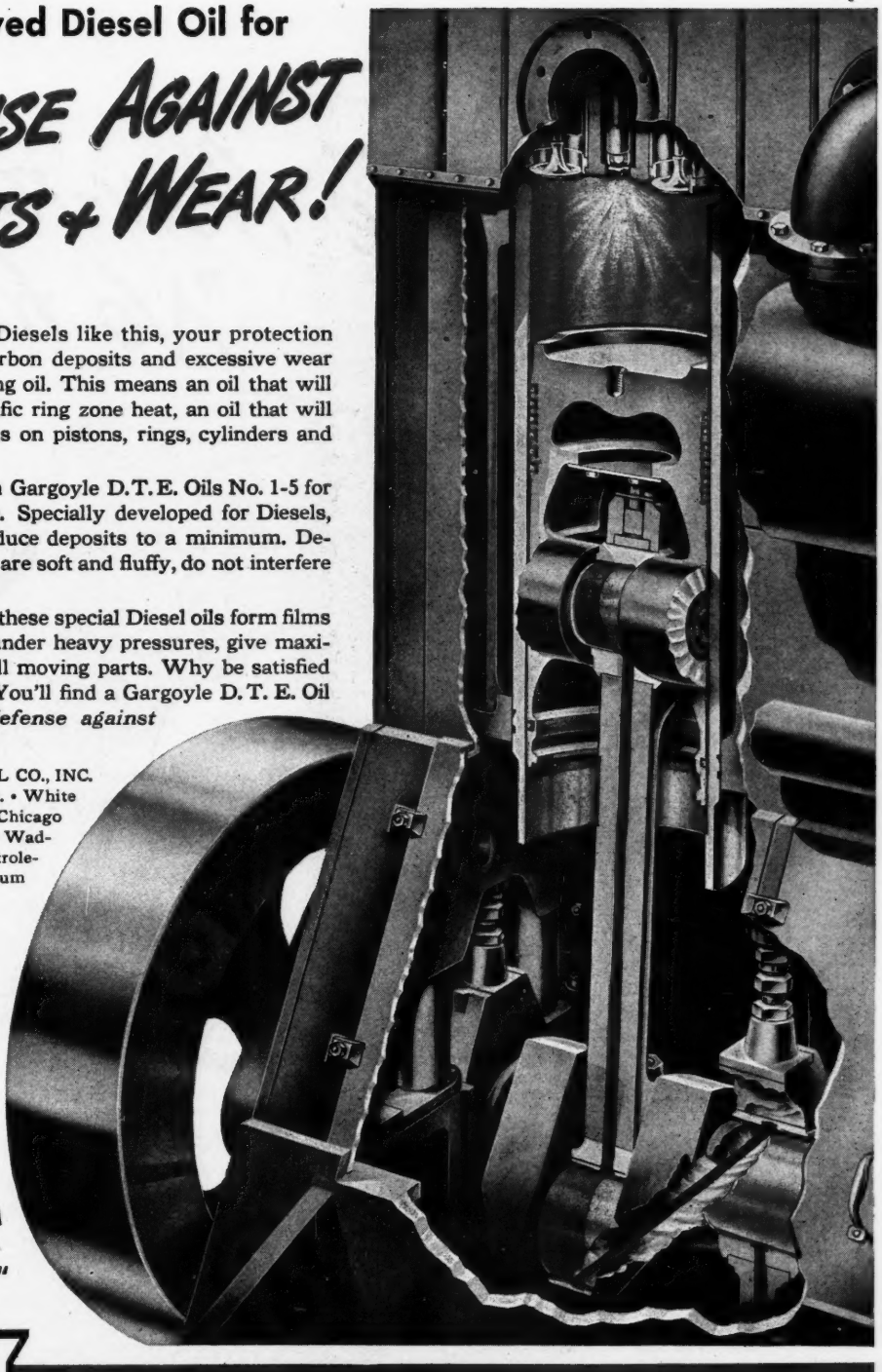
Clearance in the Terry blading may be reduced only by excessive wear of the main bearings, but even if this should occur, the projecting rims on the side of the wheel would rub on the smooth protecting surfaces of the reversing chamber, thereby automatically stopping the turbine before damage could result. Replacement of the interchangeable bearings immediately restores the original clearance.

T-1158

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.

Use a Proved Diesel Oil for

DEFENSE AGAINST DEPOSITS + WEAR!



DEEP inside big Diesels like this, your protection against hard carbon deposits and excessive wear is the right lubricating oil. This means an oil that will stand up under terrific ring zone heat, an oil that will maintain strong films on pistons, rings, cylinders and bearings.

You can depend on Gargoyle D.T.E. Oils No. 1-5 for this double-duty job. Specially developed for Diesels, these famous oils reduce deposits to a minimum. Deposits that may form are soft and fluffy, do not interfere with ring operation.

Just as important, these special Diesel oils form films that resist rupture under heavy pressures, give maximum protection to all moving parts. Why be satisfied with anything less? You'll find a Gargoyle D. T. E. Oil No. 1-5 the *best defense against deposits and wear.*

SOCONY-VACUUM OIL CO., INC.
Standard Oil of N. Y. Div. • White Star Div. • Lubrite Div. • Chicago Div. • White Eagle Div. • Wadhams Div. • Magnolia Petroleum Co. • General Petroleum Corp. of Calif.

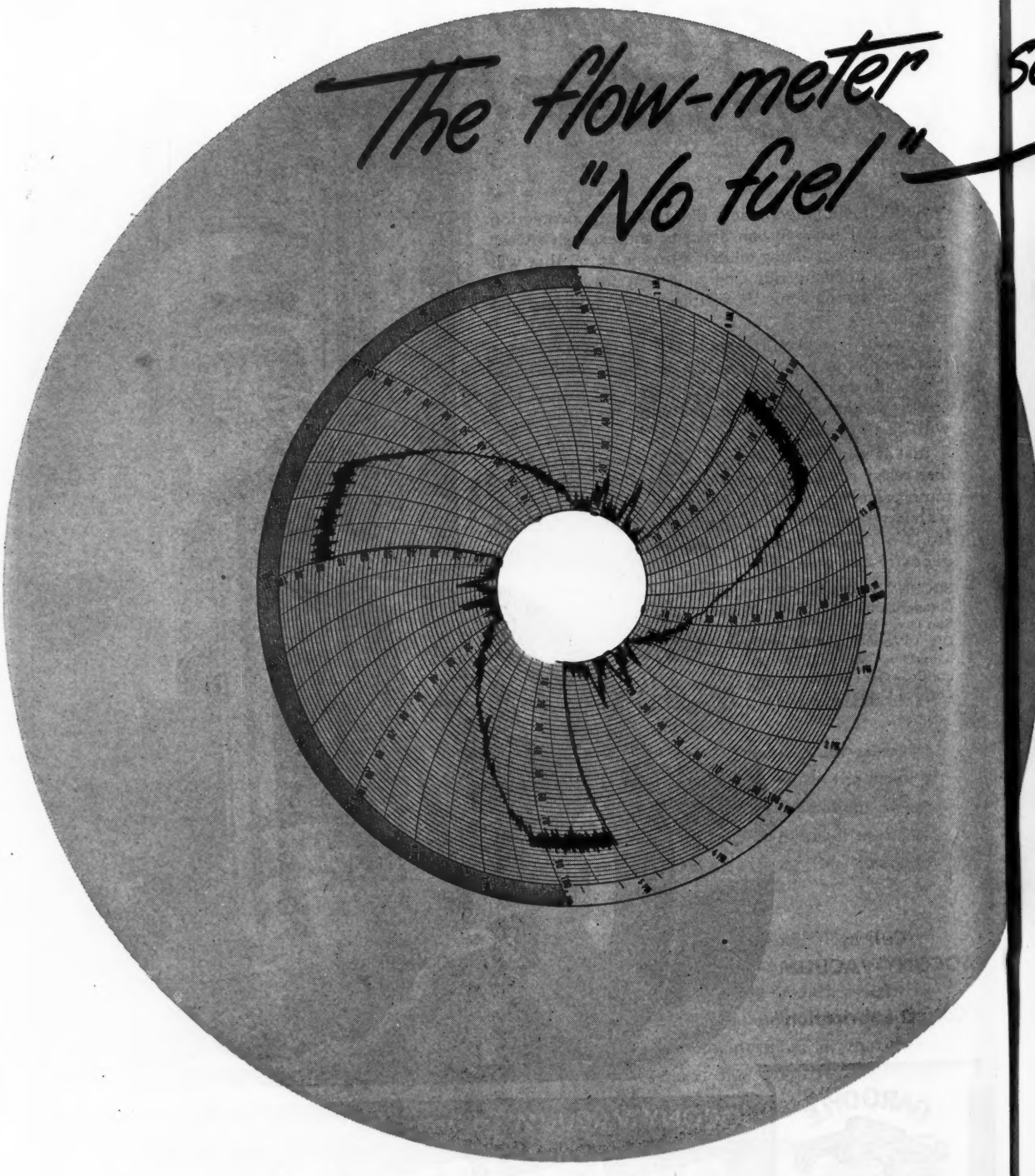
Call in SOCONY-VACUUM for "Correct Lubrication"

GARGOYLE Lubricants

SOCONY-VACUUM'S 5 Steps to Lower Production Costs:

1. Lubrication Study of Your Entire Plant
2. Lubrication Schedules and Controls
3. Lubricant Storage and Handling System
4. Skilled Engineering Counsel
5. Progress Reports of Benefits Secured

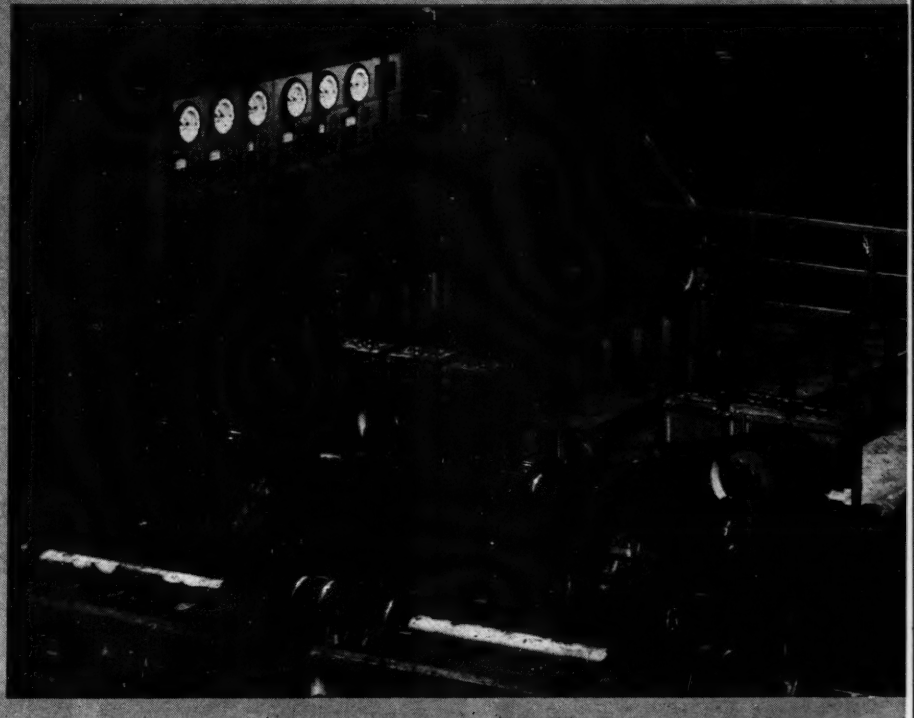
TUNE IN "INFORMATION PLEASE"—MONDAY EVENINGS, 9:30 E.W.T.—NBC



HAGAN CORPORATION, HAGAN BUILDING, PITTSBURGH 30, PA.

said

but the Hagan Control knew better



IT HAPPENS RIGHT ALONG in a Pennsylvania steel plant, where Hagan Automatic Combustion Control is used on soaking pits.

Large amounts of fuel are needed to bring the cold ingots up to temperature. After they have been heated, a very small percentage of the maximum amount holds the pit temperature at the correct level. When fuel demand drops down around 8%, the flow meter registers zero—but hour in and hour out Hagan Control continues to supply the right amount of fuel to maintain the right temperature.

Only one thing makes this possible—the Hagan principle that *controlling and recording are separate functions.*

The operation of the Hagan Automatic Combustion Control System is dependent on the functioning of a number of coordinated regulating machines, each designed for its specific job as a *regulator*. Its efficiency has not been impaired by attempting to make it serve the dual purpose of controlling and recording.

Every secondary recording instrument on the panel can be inaccurate or out of service without the slightest effect on the functioning of Hagan Control.

Write for full information.

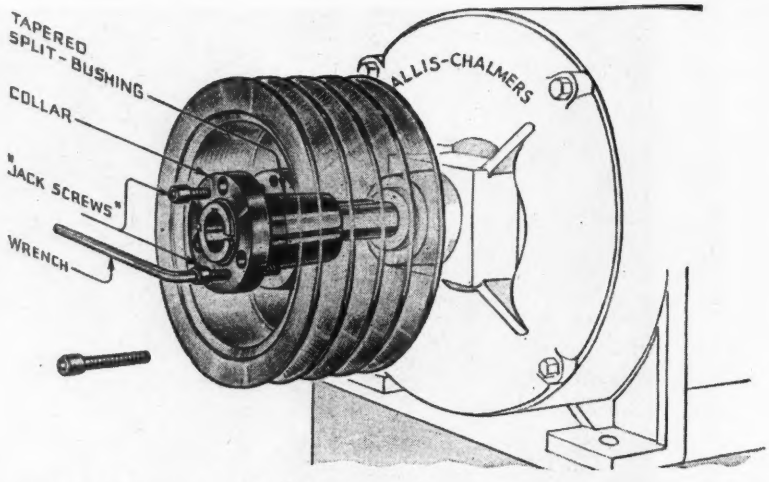
HAGAN
HALL
BUROMIN
CALGON

HAGAN *Automatic* COMBUSTION CONTROL

The pioneer . . . and still the leader

X-Ray View

OF ALLIS-CHALMERS' NEW "MAGIC-GRIP" SHEAVE



Fastest mounting and demounting sheave on the market, the new "Magic-Grip" costs you nothing extra.

1 **Remove three capscrews** from bushing collar. A handy wrench —supplied with each sheave—is the only tool needed to remove Allis-Chalmers' new "Magic-Grip" from motor or machine shaft quickly and easily.

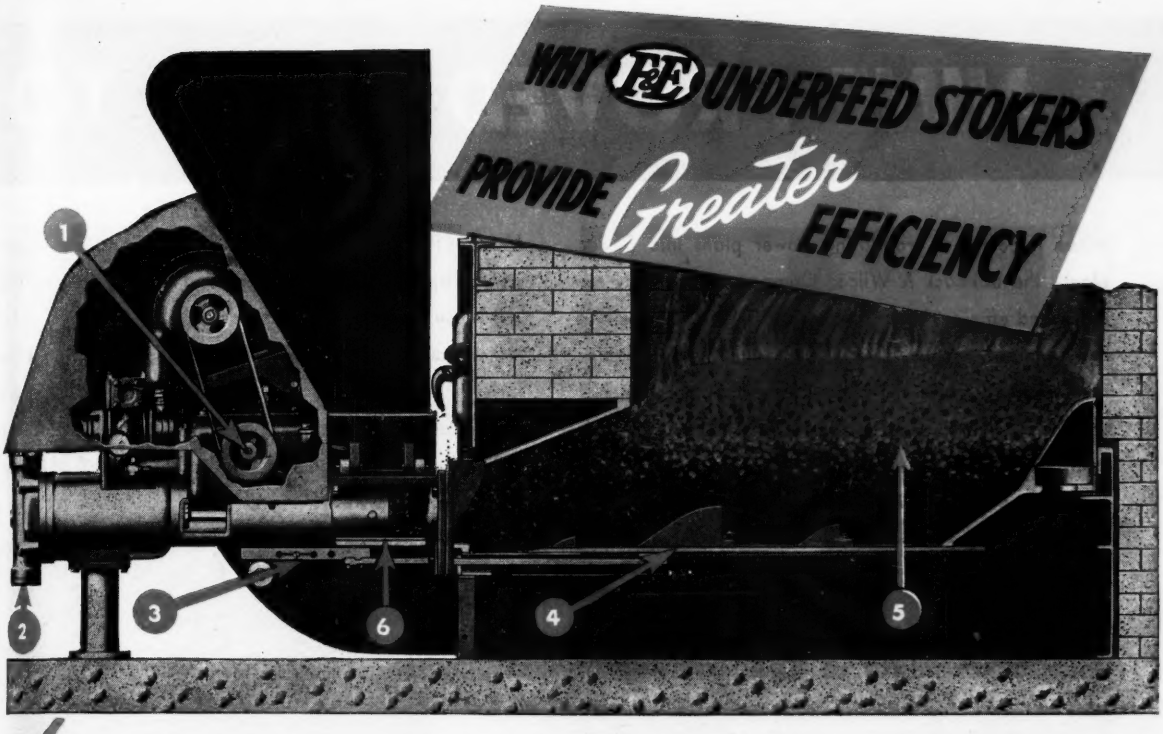
2 **Insert two capscrews** in tapped holes. As screws are turned, they become levers . . . automatically breaking tight grip of tapered split bushing on sheave and shaft. Entire unit is then ready for removal.

3 **Remove sheave from shaft.** Requires no mallet, no prying, no bulging muscles. You just slide the sheave off . . . smoothly, quickly. *It costs nothing extra!* Send for B6310. Allis-Chalmers, Milwaukee 1, Wis.

A 1770

Allis-Chalmers Texrope

"MAGIC-GRIP" **SHEAVES**



6 ADVANCED ENGINEERING FEATURES PROVIDE EVEN FUEL DISTRIBUTION, PERFECT COMBUSTION, LOW OPERATING AND MAINTENANCE COSTS

1. **UNIT TYPE-ELECTRO-HYDRAULIC DRIVE**—This type drive is an outstanding achievement in stoker design. One simple, compact mechanism—all self-contained—eliminating pipes, valves, fittings, shear pins, gears and other parts that usually leak, break, or give trouble. All moving parts are enclosed and operate in a bath of oil. Easy to keep clean. Absolutely protected against breakdowns should tramp iron and other foreign matter be fed in with the coal. Steam Drive Available.

2. **INTERVAL TIMER GOVERNOR (Patented)**—Standard equipment on all "F & E" Underfeed Stokers. Revolutionizes the feeding of coal by regulating the *time interval* between ram strokes, allowing the ram to operate FULL-STROKE, FULL SPEED at all times—a necessity in the efficient operation of an underfeed stoker. With this Governor, the operator can secure the *exact* rate of coal feed he desires.

3. **EXTERIOR FUEL BED REGULATOR**—The "F & E" Coal Distribution Regulator makes possible the regulation of the burning fuel bed from the OUTSIDE of the stoker in event of change in grade of coal . . . a further assurance of even distribution of fuel over the entire grate surface at all times.

4. **SLIDING BOTTOM RETORT**—Produces perfect underfeed action of the fuel from one end of the retort to the other. It is practically immune to distortion should the fire burn down into the retort.

5. **HIGH EFFICIENCY TUYERES**—Scientifically designed to produce efficient preparation and burning of fuel. Extremely large heat-radiating surfaces result in low maintenance.

6. **RENEWABLE RAM CASE LINER**—Ram operates in a steel liner fitted to the interior of the ram case. When wear results, original size can be restored quickly and economically by replacing the ram and liner. Another "F & E" feature designed to facilitate keeping the stoker always in best operating condition with a minimum of effort, expense and time.

This 6-FEATURE COMBINATION IS AVAILABLE ONLY IN "F & E" UNDERFEED STOKERS

Get in touch with the "F & E" representative in your locality or write direct to manufacturer for literature and case histories of what "F & E" Stokers have accomplished for others. Ask for Bulletin 1105.

FLYNN & EMRICH CO.

Established 1842

Holliday & Saratoga Sts., Baltimore 2, Md.

Representatives in Principal Cities

F&E UNDERFEED STOKERS

Bituminous and Anthracite Types—For Heating or Power Boilers Producing from 1,000 to 40,000 lbs. of steam per hour

. . NINE PROVED WAYS TO

When it comes to translating power plans into power plants, the Babcock & Wilcox Company can supply reliable and efficient boiler units complete with all essential components from fuel preparations and burning equipment to breechings and stacks. The company thus has control over both the designing and application of the equipment and coordinates the various elements to assure maximum dependability and economy of performance.

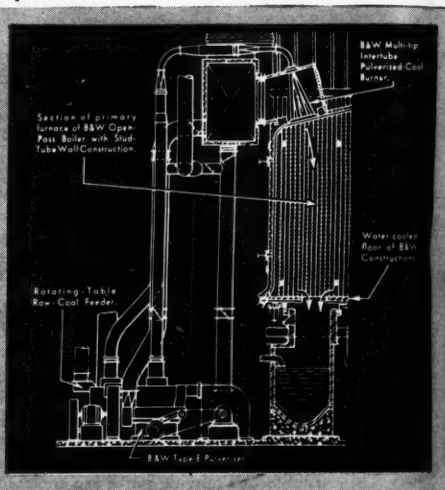
Much of the component equipment shown on these pages can be applied to modernizing, and thereby step up the efficiency of, existing power facilities.

When you select B&W steam-generating equipment for large or small plants, you get the benefit of over 60 years specialized experience in designing and fabricating boilers and related equipment with a long record of highly satisfactory service.

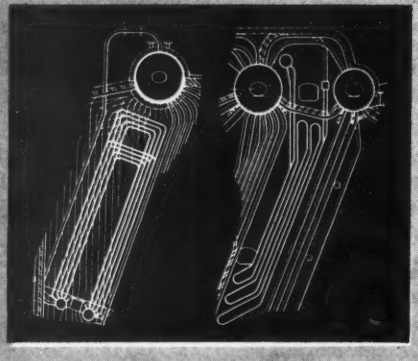
SEVEN STEPS TO A MODERN POWER PLANT

1. List minimum equipment and material essential to keep plant running for perhaps three years.
2. Meter, check, or estimate use of kwhr, steam, water, and air for each plant use, keeping postwar expansion possibilities in mind.
3. Make rough plan of the entirely new plant you would want to serve these needs. Secure costs of equipment and construction from consulting engineer or direct from manufacturers.
4. Compare new-plant plans with existing layout to find points of parallel arrangement, suitable locations for needed new items, building changes and the like.
5. Estimate fuel, labor and perhaps maintenance savings for each step of the modernization.
6. Calculate how long each individual improvement will take to pay for itself.
7. Prepare brief report suggesting that needed steps be approved first. Optional improvements can then be examined individually on the basis of the savings each will effect.

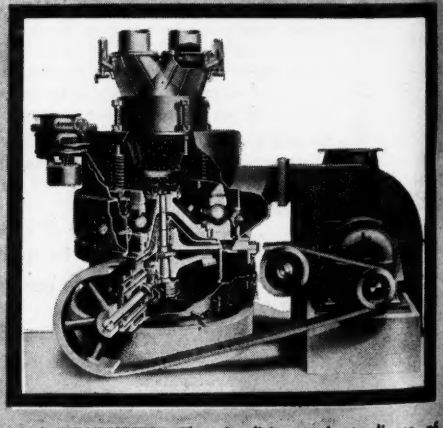
From POWER, December 1944


B&W Multi-tip Interlube Pulverized-Coal Burner
Section of primary furnace of B&W Open-Pass Boiler with Stud-Tube Wall Construction
Water-cooled floor of B&W Construction
Rotating-Table Raw-Coal Feeder
B&W Type E Pulverizer

B&W DIRECT-FIRING PULVERIZED-COAL SYSTEM. B&W direct-firing pulverized-coal system has advantages in ease of operation, reliability and upkeep that make it economical for small as well as large boilers. It is readily applied to oil-fired boilers for conversion to coal firing.

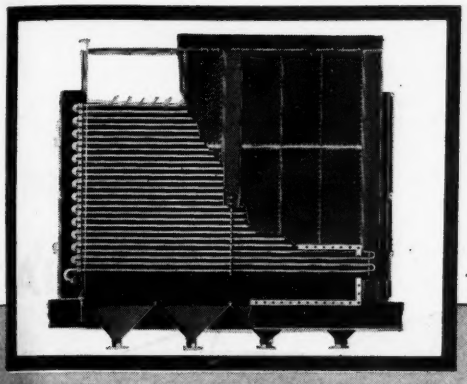


SUPERHEATERS. B&W Superheaters are properly designed and fabricated, with respect to steam and gas flow, to function efficiently with boilers designed and built by B&W. Available in both draining and non-draining types as shown.

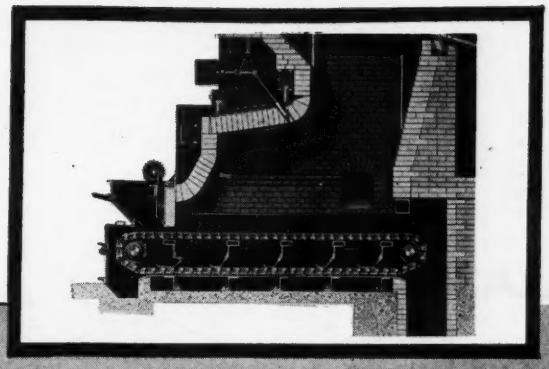


B&W PULVERIZERS. The simplicity and sturdiness of B&W ball-bearing type pulverizers assure high availability with low maintenance in direct-firing pulverized-coal systems. They provide consistently high fineness and respond quickly to changes in load with automatic control of raw-coal feed.

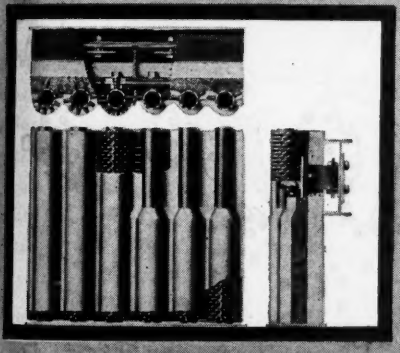
BOOST BOILER EFFICIENCY



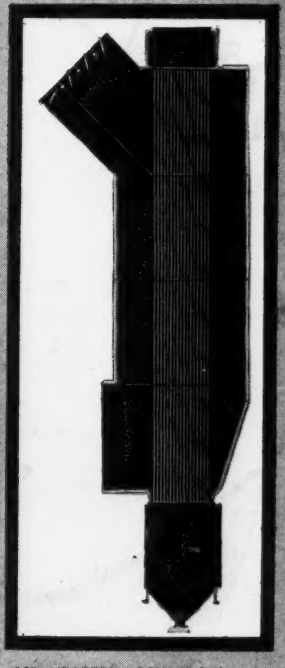
ECONOMIZERS. B&W Economizers effect appreciable savings in fuel and can be built to meet the size and pressure requirements of any installation. The Return-Bend Economizer shown can be easily cleaned, and pressure parts may be inspected externally while in service.



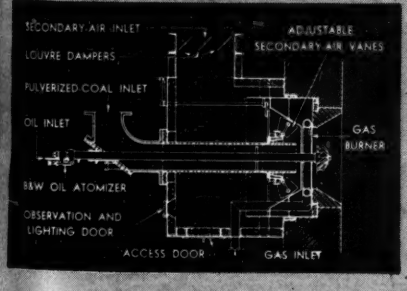
CHAIN-GRATE STOKERS. Babcock & Wilcox Chain-Grate Stokers are widely used with free-burning bituminous coal, anthracite, lignite, and coke breeze. They can be furnished for natural, induced, or forced draft, depending upon operating conditions.



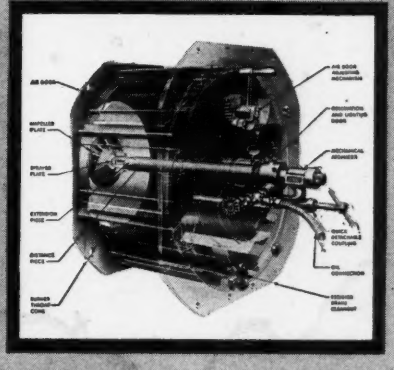
WATER-COOLED FURNACE CONSTRUCTIONS. B&W Water-Cooled Furnace Constructions are extensively applied for partial or complete water cooling of furnaces of all sizes, shapes, and forms, and with all fuels and combustion methods. Studded-tube type of construction is shown.



AIR HEATERS. B&W Tubular Air Heaters are inherently tight and efficient, and are easy to keep clean. Available in multi-pass gas flow type, as shown, or longitudinal gas-flow type, and in sizes to meet the requirements of any boiler installation.



MULTIFUEL CIRCULAR BURNER. Pulverized solid fuels, oil, and gas are burned singly or in any combination with this burner. It provides a single means of efficiently burning a wide range of fuels, permitting advantage to be taken of variations in the availability and market prices of these fuels.



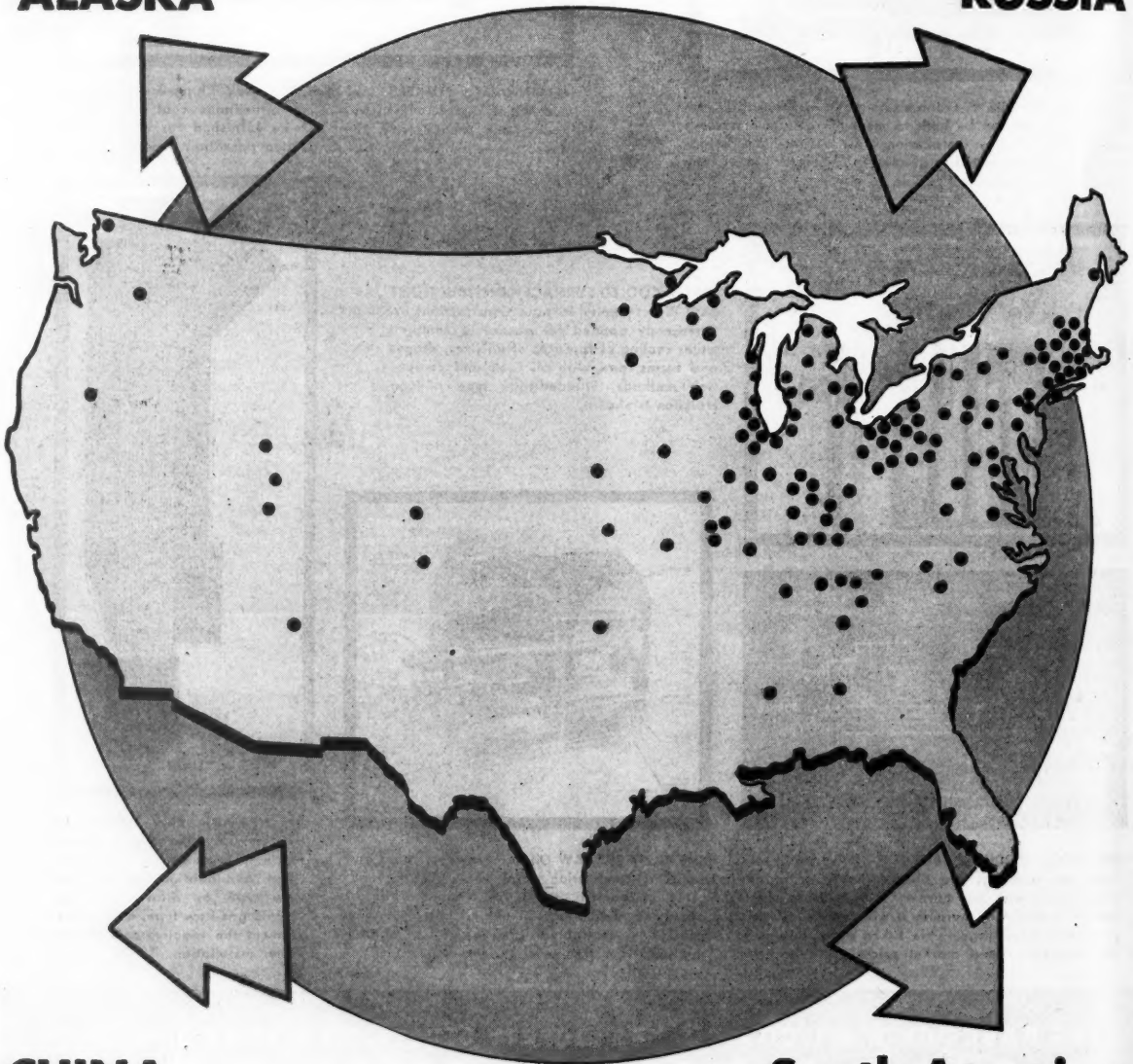
OIL BURNERS. B&W Oil Burners effect rapid and complete combustion at all rates of fuel feed, using mechanical, steam, or steam-mechanical atomizers, depending on the oil and operating conditions. Available in a range of heat liberating capacities that meet all requirements.

THE BABCOCK & WILCOX CO. • 85 LIBERTY STREET, NEW YORK 6, N. Y.

BABCOCK & WILCOX

G-294G

SPREADING ALL

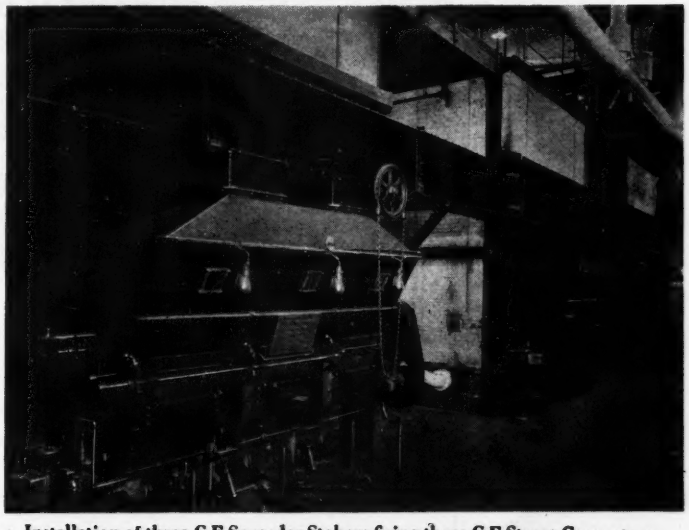


OVER THE MAP

because

C-E SPREADER STOKERS BURN NOT ONLY CHEAPER COAL BUT A WIDER VARIETY OF COALS

They Are Spreading Economy, Spreading Convenience, Spreading in Use



• Installation of three C-E Spreader Stokers firing three C-E Steam Generators, Type VU.

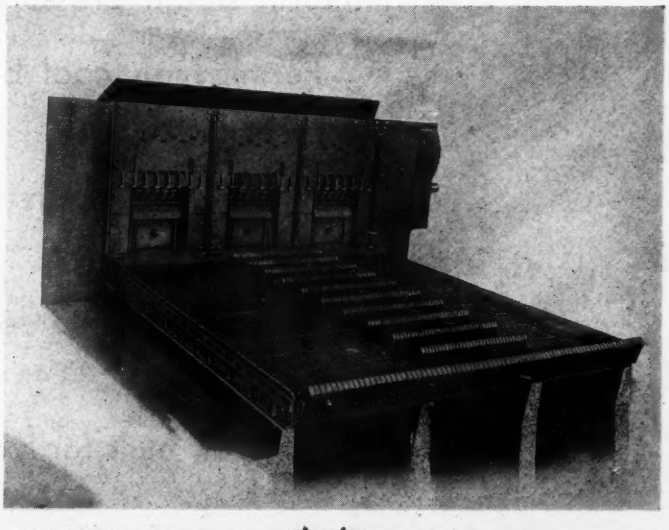
Even when peace comes, poor coal is something industry will have to live with for some time. Yet, for a rapidly growing number of industrial plants, poor coal will not be a serious handicap in steam generation. For, thanks to the installation of C-E Spreader Stokers, these foresighted plants are now able to utilize almost any grade or type of coal available.

It is one of the virtues of the C-E Spreader Stoker that it will burn satisfactorily not only the cheaper coals but a greater variety of coals both good and bad. Because of this all-round versatility, plus convenience and economy, the use of these advanced design stokers is spreading all over the world.

C-E Spreader Stokers have been applied to boilers of all types with capacities ranging from about 5,000 to 175,000 lb of steam per hr. They are used in a wide variety of fields — chemical, metallurgical, refining, food, rubber, distilling, brewing, railway, marine, utilities, schools, hospitals, laundries, light and heavy manufacturing.

If C-E Spreader Stokers are suitable for your plant — and they probably are — you can face the handicap of poor coal with assurance by planning now for an early installation. A-863

• Rear view of C-E Spreader Stoker with one section of the grates in dumping position.



COMBUSTION ENGINEERING

200 MADISON AVENUE, NEW YORK 16, N. Y.

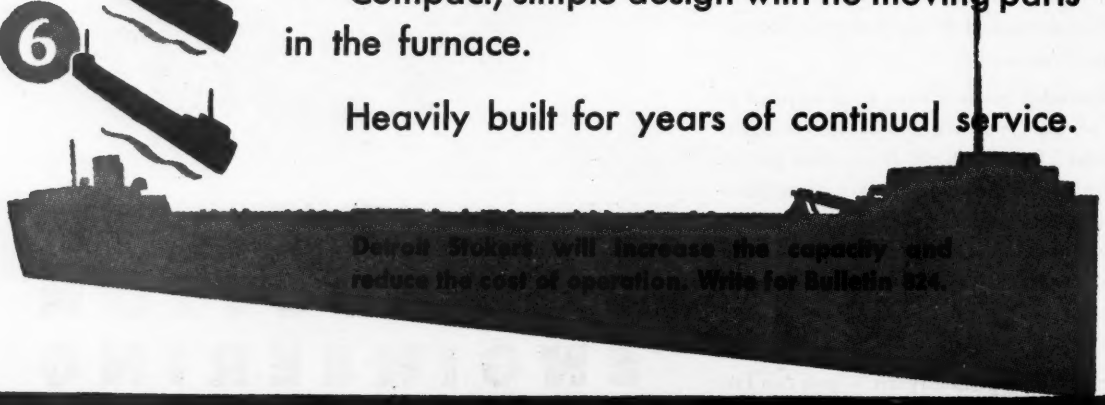
C-E PRODUCTS INCLUDE ALL TYPES OF BOILERS, FURNACES, PULVERIZED FUEL SYSTEMS AND STOKERS; ALSO SUPERHEATERS, ECONOMIZERS AND AIR HEATERS

DETROIT ON

Over three-fourths of all the turbine driven bulk freighters of the Great Lakes fleet use Detroit RotoStokers.

Many repeat orders by leading boat Operators. Reasons why Detroit RotoStokers are favored:

1. Successfully burn a wide range of coal.
2. Handle widely fluctuating loads maintain uniform steam pressure.
3. Permit high coal burning rates per square foot of grate area.
4. Banking losses are low, due to the extremely thin fuel bed.
5. Compact, simple design with no moving parts in the furnace.
6. Heavily built for years of continual service.

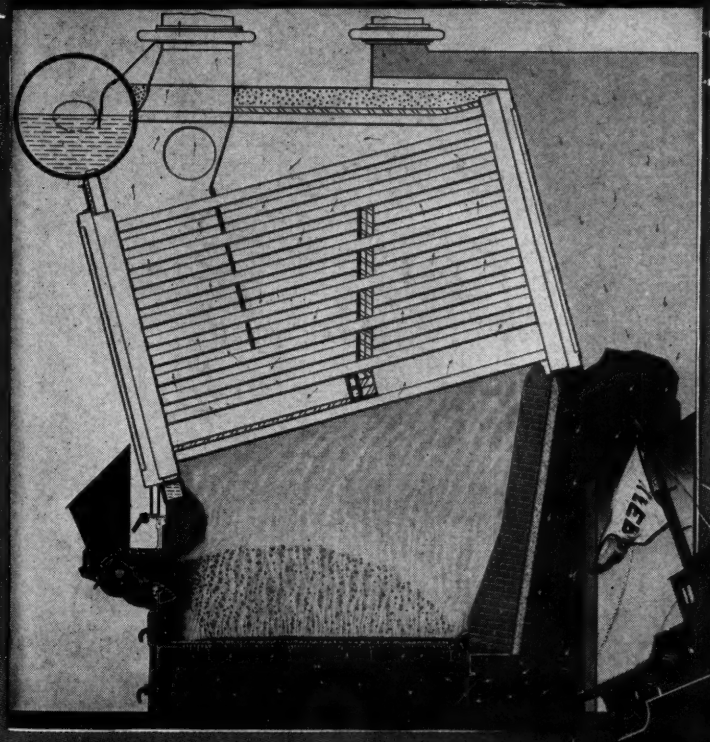


Detroit Stokers will increase the capacity and reduce the cost of operation. Write for Bulletin 824.

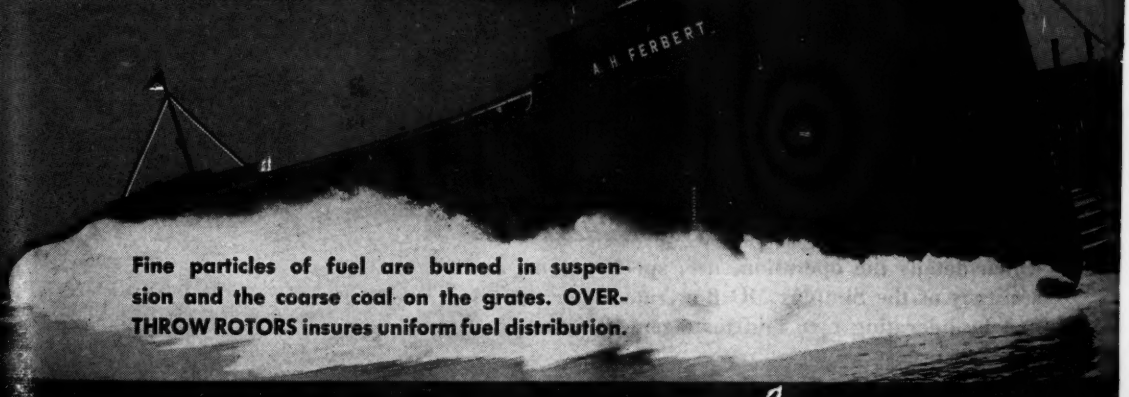
DETROIT STOKER COMPANY

THE GREAT LAKES

DETROIT ROTOSTOKERS ALSO SOLVE
MARINE STEAM PRODUCTION PROBLEMS



Detroit RotoStoker (stationary grate type) applied to a cross drum boiler for marine application. Air for combustion may be preheated.



Fine particles of fuel are burned in suspension and the coarse coal on the grates. OVERTHROW ROTORS insures uniform fuel distribution.

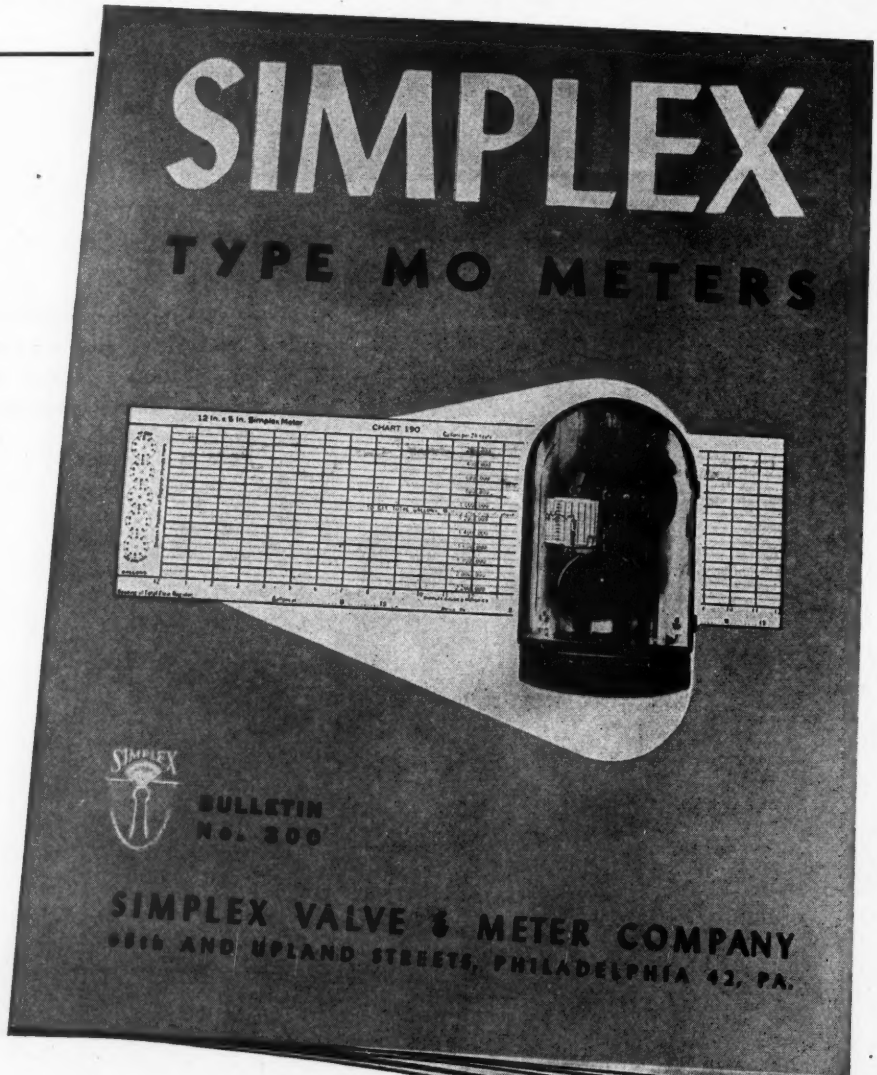
GENERAL MOTORS BUILDING • DETROIT 2, MICHIGAN

Works at Monroe, Michigan • District Offices in Principal Cities • Built in Canada at London, Ontario

HERE ARE ALL THE FACTS ABOUT THE

SIMPLEX TYPE MO METER

The High-Accuracy Flow Rate Meter



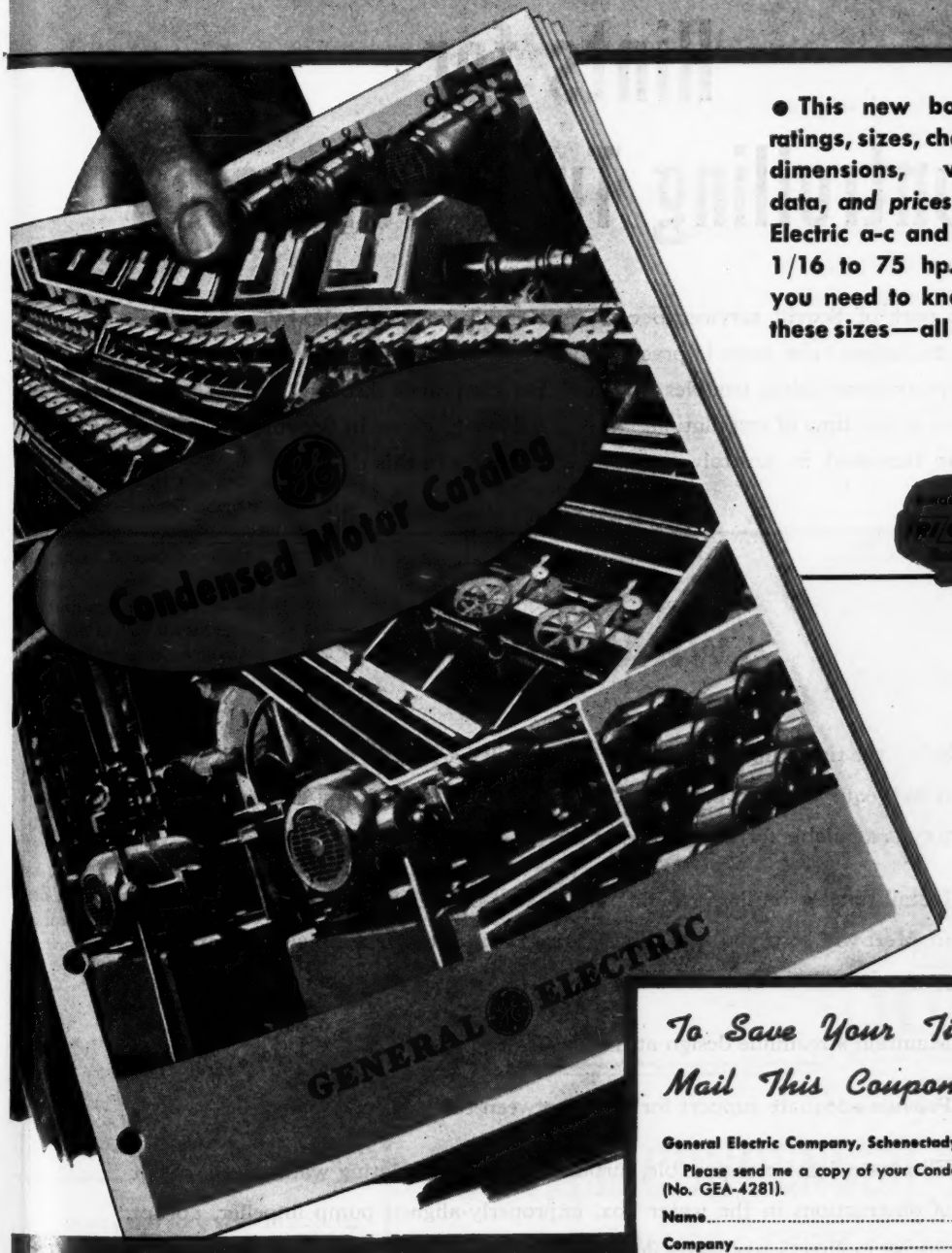
Write today for your copy of Bulletin 300 **which details the operation, use, specifications, and accuracy of the Simplex MO flow rate meter. Specified by operating men and management from coast to coast.**

SIMPLEX VALVE & METER COMPANY

6783 UPLAND STREET, PHILADELPHIA 42, PA.

BOILED DOWN

TO SIMPLIFY MOTOR SELECTION



● This new booklet gives ratings, sizes, characteristics, dimensions, where-to-use data, *and prices* of General Electric a-c and d-c motors, 1/16 to 75 hp. Everything you need to know to select these sizes—all in 16 pages!

Buy all the BONDS you can—*and keep all you buy*

To Save Your Time Later Mail This Coupon Today—

General Electric Company, Schenectady 5, N. Y.

Please send me a copy of your Condensed Motor Catalog (No. GEA-4281).

Name.....

Company.....

Address.....

City.....**State**.....

750-268-485

GENERAL ELECTRIC

Scovill Tube News

Vol. 3 SCOVILL MANUFACTURING COMPANY, Waterbury 91, Conn. No. 1

Hints for Controlling Tube Corrosion

An important part of Scovill service to condenser and heat exchanger tube users is practical aid in providing protection against troubles which cannot be foreseen at the time of installation.

This service is furnished in several ways — through personal calls by our engineers, through literature such as the Scovill Condenser Tube Booklet, and through the suggestions, like the following, given in Scovill Tube News, published regularly in this magazine.

WHAT TO DO

1. Select the right tube alloy for the job. Scovill *Service in Metals* can help you. A well-equipped and competently-staffed metallurgical and chemical laboratory is available for this purpose.
2. Install tubes carefully, avoiding undue stressing of the metal. Scovill *Service in Men* will help you here, and you can also obtain valuable information on proper installation practice from Scovill *Service in Manuals*.
3. Maintain streamline design at inlet ends of tubes.
4. Provide adequate support for tubes between tube sheets.
5. Eliminate, insofar as possible, turbulent flow of circulating water as the result of obstructions in the water box, improperly-aligned pump impeller, abrupt change in direction of water flow, etc.

OTHER PRECAUTIONS

1. Don't neglect adequate screening of the circulating water.
2. Don't allow cracks, crevices or other recessed openings between tubes and tube sheets, support plates, baffles, etc.
3. Don't permit air to become entrained with circulating water.
4. Clean tubes periodically, particularly if harmful deposits enter and lodge in tubes.
5. Don't overlook possible hot spots or other local overheating of tubes, due to direct impingement of hot gases, vapors, etc., or heavy deposits of scale, etc.

Scovill Seamless Condenser Tubes

From raw material to finished product, each step in the manufacture of Scovill Seamless Condenser Tubes is performed on modern machines and equipment by careful, skilled operators. Process inspection, a rigid finish inspection and constant metallurgical supervision are all an integral part of the manufacturing procedure.

That is the reason for the uniform high quality of Scovill Tubes. That is the reason for enviable service records of Scovill Tubes in the field.

But Scovill interest in condenser tubes goes far beyond their manufacture. Scovill has pioneered in the study of condenser tube corrosion and, of more importance, in ways and means of combating corrosion so that maximum tube life may be assured under any particular service conditions. Scovill engineers are well qualified to study your particular problems and to offer suggestions for overcoming them. Scovill engineers are competent through training and experience to make field inspections of condenser tube installations followed by recommendations and suggestions for improving tube life. Wherever necessary, such inspection and examination can be supplemented by studies of individual corrosion problems in our metallurgical and chemical laboratories.

Thus, Scovill is ready to meet your condenser tube requirements by manufacturing tubes in a complete range of sizes and alloys and, in addition to this *Service in Metals*, also offers *Service in Men* and *Service in Manuals*.

For further demonstration of *Service in Manuals*, including more detailed discussion of the Do's and Don't's mentioned above, write for a free copy of "Condenser Tube Booklet", addressing Scovill Manufacturing Company, 17 Mill Street, Waterbury 91, Conn.

THIS IS NUMBER FOURTEEN in a Series of Scovill Advertisements to help you get longer life from condenser and heat exchanger tubes.

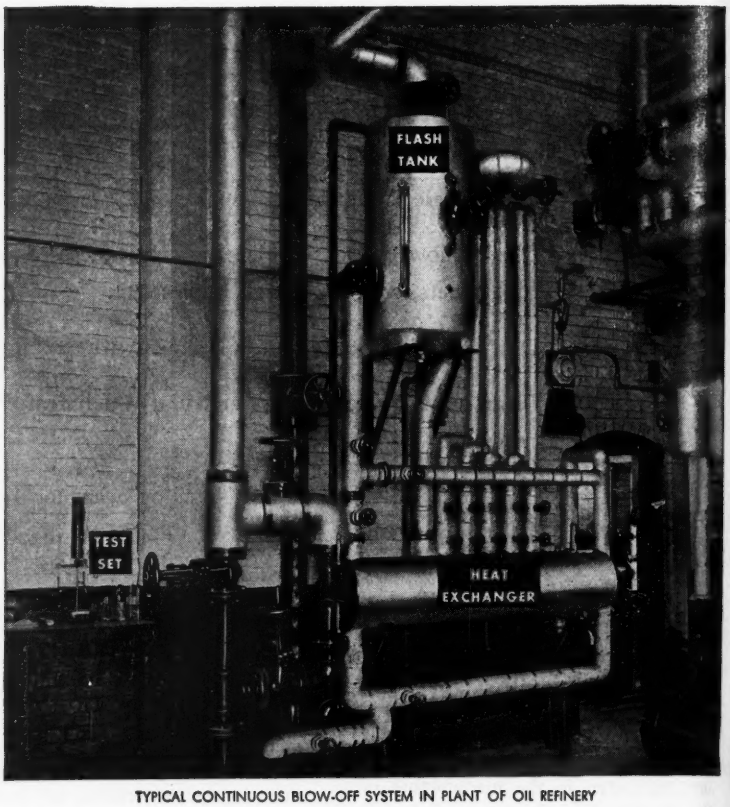
Scovill
MANUFACTURING COMPANY
WATERBURY, CONN.

SCOVILL CONDENSER TUBES

ONE PRODUCT... THREE SERVICES

Service in Manuals... Service in Metals... Service in Men

Continuous Blow-off Pays Back Original Cost More Quickly Than Almost Any Other Single Piece of Equipment

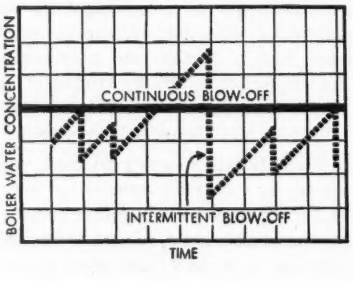


TYPICAL CONTINUOUS BLOW-OFF SYSTEM IN PLANT OF OIL REFINERY

The installation of Cochrane Continuous Blow-Off equipment recovers practically *all the heat* in the water, the only heat wasted being that which corresponds to the difference between the incoming cooling water and the blow-off water going to the Sewer.

The savings that this represents is such that in most cases the cost of the equipment can be realized in a year's time, giving a return of 100% on the investment.

As an example, an installation in the boiler plant of a large sugar company cost $1600. The first year it saved $3480, the second year it saved $3640.



MAINTAINS UNIFORM CONCENTRATIONS

With intermittent blow-down the boiler water concentration would be erratic varying from the low point to the high point between blow-downs. This is not only wasteful of heat, but may also result in foaming and priming or carry-over.

THE FLASH PRINCIPLE

Cochrane employs the flash principle in which the concentrated boiler water is flashed at a lower pressure, generating steam that can be utilized for a transfer of heat to the feedwater in the open or deaerating heater.

PUBLICATION AVAILABLE

Cochrane Publication No. 4081 describes many types of Continuous Blow-Off Systems, making it easy to judge the type best suited to your own requirements. Write today for a copy of this interesting study. Just drop a post card—but do it now.

COCHRANE CORPORATION **3123 N. 17th ST., PHILADELPHIA 32, PA.**

COCHRANE

SOFTENERS • DEAERATING SOFTENERS • DEAERATORS • METERS • STEAM SPECIALTIES

LUBRICATION ENGINEERING . . . LUBRICATION ENGINEERING . . . LUBRICATION ENGINEERING . . .

One oil . . . with many uses . . . that does each job better

STANOIL

STANOIL was developed to make it possible for you to use one or two grades of the *same* oil on many types of lubricating jobs in place of *many* special oils—one type for each job. Such an oil offers these advantages:

1. Simplifies lubricant stocks—which may mean fewer containers and dispensers—requiring less storage space—less clerical work in ordering lubricants and maintaining inventories.

2. Reduces possible confusion of lubricant application by reducing the number of brands of oil to be handled.

3. Makes possible the use of a higher grade lubricant throughout the plant.

4. Gives the cost advantage of large quantity buying.

Uses for Stanoil in plant lubrication have far exceeded those foreseen for it. Typical applications that have been made of Stanoil—and the improvement in operation it made—are briefly described here. There may be *many* operations in your plant where Stanoil will bring reduced maintenance and lubricating costs—plus the advantages listed.

A Standard Oil Lubrication Engineer will help you pick the jobs and apply Stanoil to simplify your lubrication. Write Standard Oil Company (Indiana) office, 910 South Michigan Avenue, Chicago 80, Illinois, for the Engineer nearest you.

Engine oil in a high speed steam engine in a Missouri plant emulsified badly and foamed because of the moisture escaping along the rod. The high demulsibility of Stanoil eliminated the emulsion and foaming.

Rotary compressor blade breakage was troublesome in an Indiana plant. When the battery of compressors was switched to Stanoil, wear was reduced, resulting in the complete elimination of breakage.

Hydraulic system in a shaper. The higher stability of Stanoil in the hydraulic system of a machine tool shaper reduced oil changes, provided better lubrication, and resulted in a 30% savings in lubrication costs.

Homogenizers in a food plant required an oil-change once a week in the oil-operated system of pumps and plungers. With Stanoil, oil-change periods were increased to once a month because of its higher stability and long-lasting quality.

Gasoline Powers the Attack . . . Don't Waste a Drop!

STANDARD OIL COMPANY (INDIANA)

STANDARD SERVICE

★ LUBRICATION ENGINEERING

For easier handling in grease guns... longer life in anti-friction bearings

• THOSE TWO ADVANTAGES—easier handling, longer life—can materially reduce lubricating cost on the many anti-friction bearings in motors and machines in your plant. Stanobar Grease is a newcomer in the Standard Oil line—developed during the war. It has been tried in the proving ground of severe wartime demands and has made good on every claim for it.

Stanobar Grease was specifically designed to provide the benefits listed at the right. A Standard Oil Lubrication Engineer will be glad to help you put these cost-reducing qualities of Stanobar to work on your equipment. Write Standard Oil Company (Indiana), 910 South Michigan Ave., Chicago 80, Illinois, for the Engineer nearest you.

Easier handling in grease guns and central lubricating systems is the result of the smooth (non-fibrous) structure of Stanobar. Two grades—Stanobar No. 2 for grease gun or hand-packing applications, and Stanobar "S," a soft consistency for volume dispensing in central lubricating systems—meet practically all anti-friction bearing requirements.

Longer lasting quality in Stanobar is obtained by the use of a special inhibitor which prevents oxidation. This means longer periods of operation between filling or cleaning and packing bearings.

Greater resistance to thinning out when "worked" in bearings reduces the possibility of leakage and may also permit the use of one grade of Stanobar in place of three or four greases now needed for various plant requirements.

Easy application is an advantage of Stanobar which is unusual in many greases suitable for high temperature service.

Buy more War Bonds

STANDARD OIL COMPANY (INDIANA) STANDARD SERVICE

The Engineer Says

"WHAT A RELIEF!"

Many a power plant engineer has made this remark after installing GARLOCK Packings and Gaskets. No more leaks in boilers, pipe lines and pumps—and everybody's happy!

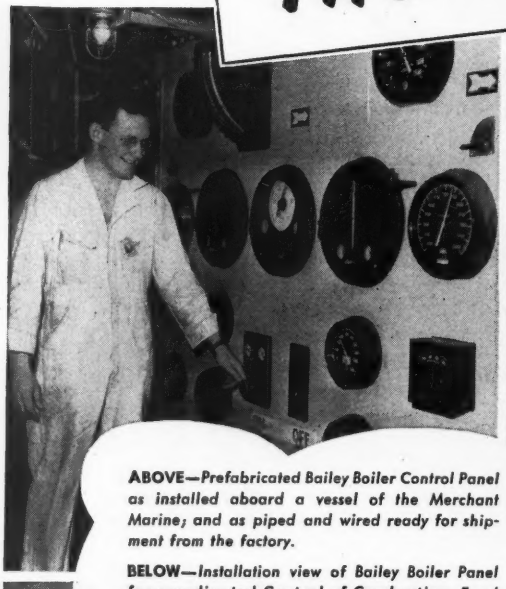
GARLOCK products give long, dependable service because they are manufactured in our own plant and are *quality-controlled* from raw material to finished product.

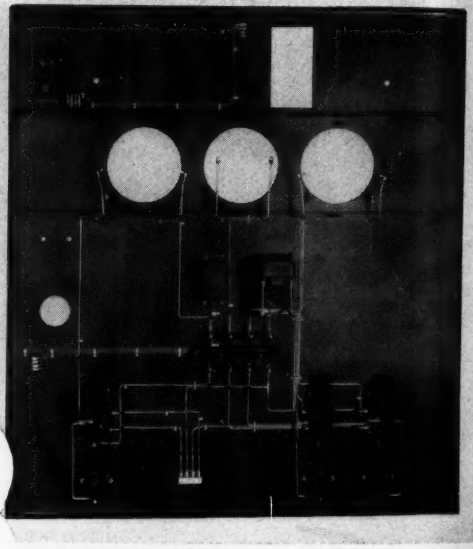
THE GARLOCK PACKING COMPANY
PALMYRA, NEW YORK
Manufacturers of GARLOCK *Packings, Gaskets and* KLOZURE *Oil Seals*
In Canada: The Garlock Packing Company of Canada Ltd., Montreal, Que.

GARLOCK 234 gives long, dependable service on rotary or centrifugal pumps handling hot water, cold water, caustic solutions or weak acids. All sizes from ⅛" to 1¼".

Garlock

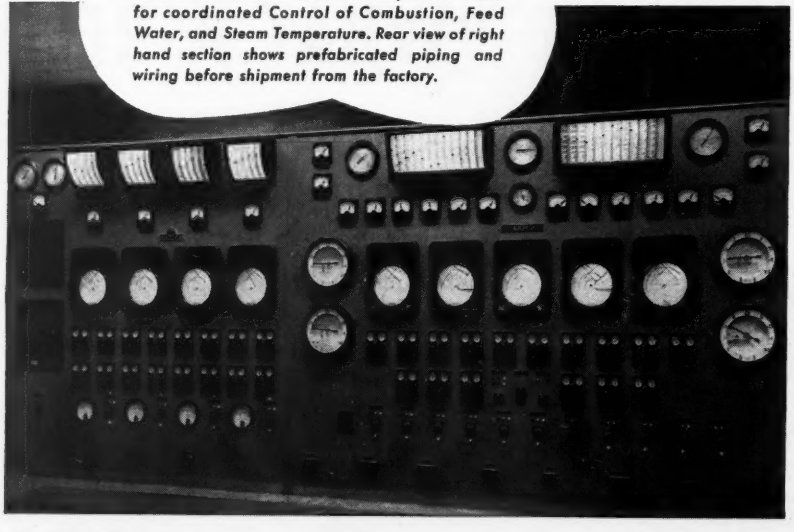
SIMPLIFY BOILER CONTROL INSTALLATION

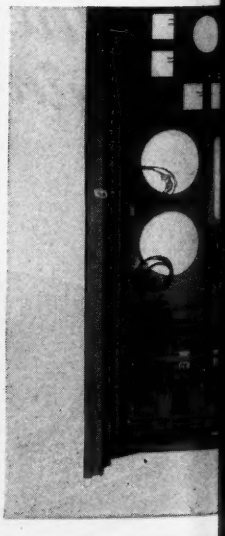




ABOVE—*Prefabricated Bailey Boiler Control Panel as installed aboard a vessel of the Merchant Marine; and as piped and wired ready for shipment from the factory.*

BELOW—*Installation view of Bailey Boiler Panel for coordinated Control of Combustion, Feed Water, and Steam Temperature. Rear view of right hand section shows prefabricated piping and wiring before shipment from the factory.*





BAILEY METER CONTROL

BOILER METERS • MULTI-POINTER GAGES • FLUID METERS • RECORDERS • SUPERH TRO

PREFABRICATED BAILEY CONTROL PANELS

Cut Installation Time, Forestall Piping and Wiring Errors, Insure Use of Suitable Materials, Present Finished Appearance, Reduce Total Cost, and Simplify Field Engineering . . .

★ Prefabricated Bailey Control Panels are welcome equipment to the erection crew and to the engineers responsible for installation.

Each panel comes neatly wired and piped with all connections thoroughly checked by trained instrument mechanics. Small units such as switches, signals, valves and relays are mounted and connected ready for action. Cut-outs, drilling, and all necessary connections are provided for meters which must be shipped unmounted. These are mounted after the panel is secured in its final location.

Prefabricated Bailey Control Panels may include not only interconnecting air-operated control piping, but instrument connections, and electrical wiring as well if desired. The installation of all this wiring and piping at the same time according to a coordinated plan insures a neat appearing finished product with an orderly arrangement of all connections.

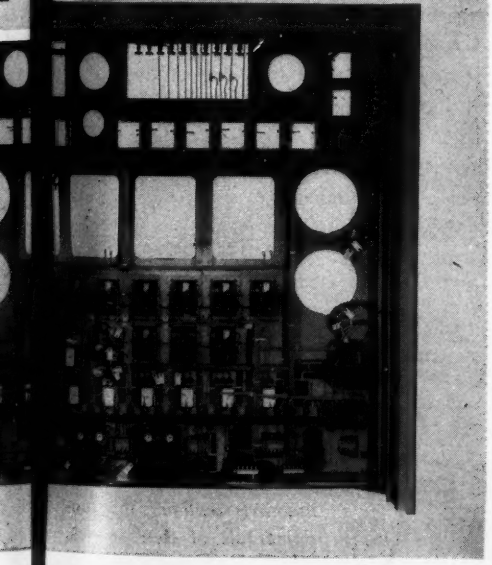
Instrument piping, outgoing air-control lines and electric wires are attached to convenient terminals and tagged to insure proper connections.

The Bailey Engineer in your community will be glad to help you apply the time and money saving features of prefabricated control panels to the particular requirements of your plans for new construction or modernization.

A-91

FOR COORDINATED BOILER CONTROL

Prefabricated Bailey Boiler Control Panels simplify the coordination of combustion, feed water, steam temperature, heater levels, pump speeds and other related factors which all must be in balance to insure optimum boiler performance.



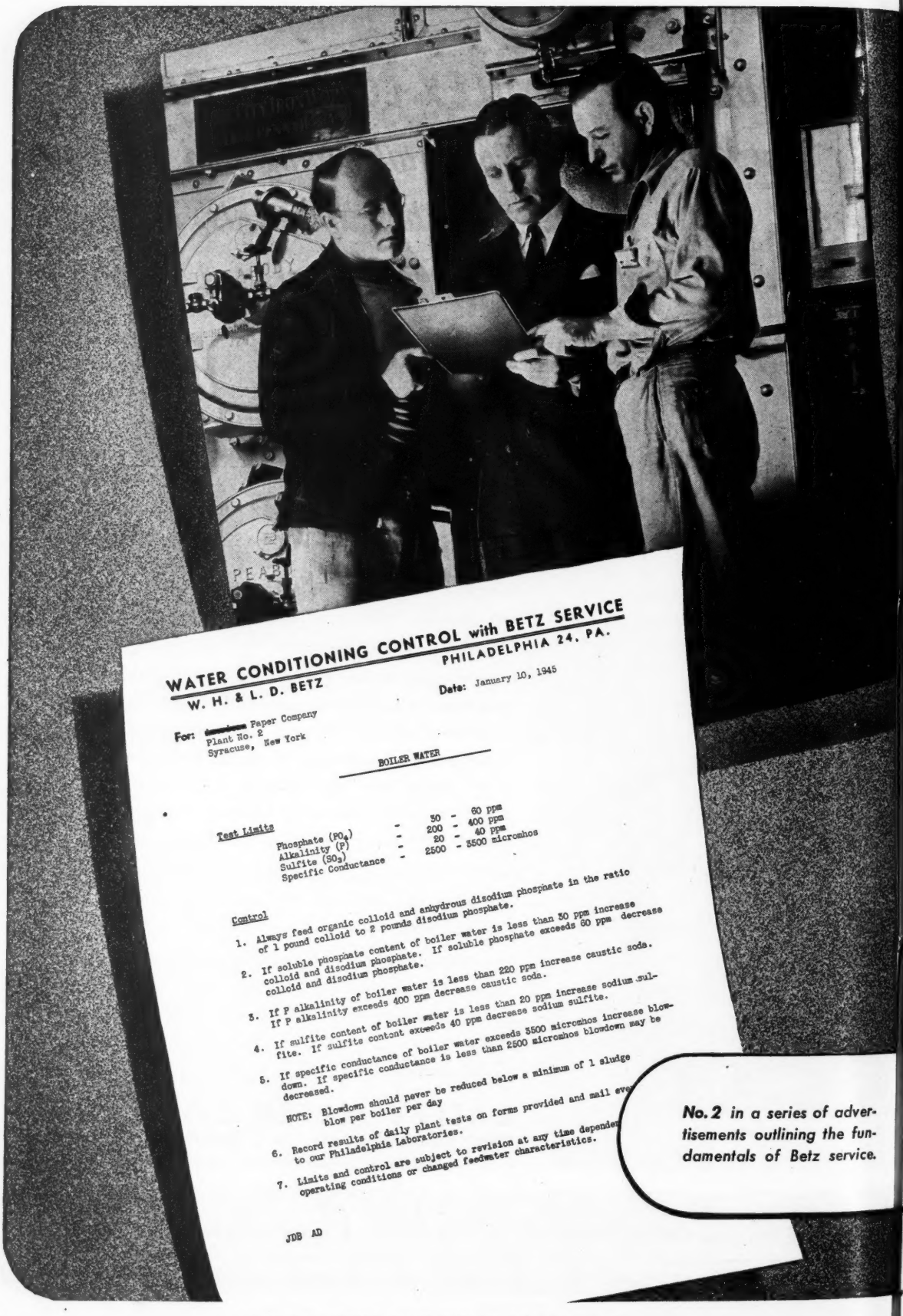
BAILEY METER COMPANY

1040 IVANHOE ROAD • CLEVELAND 10, OHIO

Bailey Meter Company Limited, Montreal, Canada

. . . The Complete Boiler Control System

RHEOSTROL • DESUPERHEAT CONTROL • COMBUSTION CONTROL • FEED WATER CONTROL



WATER CONDITIONING CONTROL with BETZ SERVICE

W. H. & L. D. BETZ PHILADELPHIA 24, PA.

Date: January 10, 1945

For: [redacted] Paper Company
Plant No. 2
Syracuse, New York

BOILER WATER

Test Limits			
Phosphate (PO_4)	-	30 - 60	ppm
Alkalinity (P)	-	200 - 400	ppm
Sulfite (SO_3)	-	20 - 40	ppm
Specific Conductance	-	2500 - 3500	micromhos

Control

1. Always feed organic colloid and anhydrous disodium phosphate in the ratio of 1 pound colloid to 2 pounds disodium phosphate.
2. If soluble phosphate content of boiler water is less than 30 ppm increase colloid and disodium phosphate. If soluble phosphate exceeds 60 ppm decrease colloid and disodium phosphate.
3. If P alkalinity of boiler water is less than 220 ppm increase caustic soda. If P alkalinity exceeds 400 ppm decrease caustic soda.
4. If sulfite content of boiler water is less than 20 ppm increase sodium sulfite. If sulfite content exceeds 40 ppm decrease sodium sulfite.
5. If specific conductance of boiler water exceeds 3500 micromhos increase blowdown. If specific conductance is less than 2500 micromhos blowdown may be decreased.

NOTE: Blowdown should never be reduced below a minimum of 1 sludge blow per boiler per day

6. Record results of daily plant tests on forms provided and mail eve to our Philadelphia Laboratories.
7. Limits and control are subject to revision at any time depende operating conditions or changed feedwater characteristics.

JDB AD

No. 2 in a series of advertisements outlining the fundamentals of Betz service.

HOW BETZ ESTABLISHES *Individual* BOILER WATER CONTROL

• Proper boiler water conditioning requires far more than the mere addition of a fixed amount of chemicals to the boiler water. It has been repeatedly proved that a system of control must be established to compensate for daily variations in operating conditions and feedwater characteristics; otherwise, costly over-treatment or dangerous under-treatment will inevitably result.

An essential part of the complete supervisory service extended by W. H. & L. D. BETZ is the establishment of this vitally-important plant control. An individually designed control chart (shown in typical form on the facing page) is prepared from our study of plant operating data and water characteristics. Upon delivery to the plant by a Betz engineer its application is thoroughly explained to the plant personnel. This chart outlines the steps to be taken in maintaining proper boiler water balances at all times with respect to both chemical treatment and blowdown. A similar chart is prepared for the control of external treatment. Our engineer then aids in the initial establishment of proper chemical balances as recommended by these control charts. A few simple, daily chemical tests recommended to maintain the proper balances are also explained. In this manner, a complete understanding of the desired feedwater correction and control is assured from the outset.

Unscheduled boiler outages can be prevented through the supervisory services and control of W. H. & L. D. BETZ. Our engineers and chemists know how to keep boilers operating 'round the clock. Years of experience with all types and sizes of installations and with widely varying feedwaters enables Betz to render a boiler water service that is complete for all industries, with individual recommendations and control for each plant.

W. H. & L. D. BETZ

Gillingham & Worth Sts., Philadelphia 24, Pennsylvania

THE 6 FUNDAMENTALS OF BETZ BOILER WATER CONDITIONING SERVICE

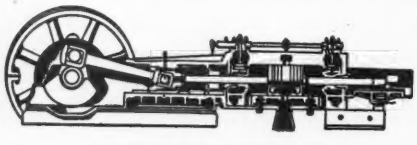
1. Complete plant investigation and report.
2. **Establishment of plant control.**
3. Daily plant control tests.
4. Detailed review of plant tests and report.
5. Supplementary complete laboratory analyses.
6. Periodic "check-up" visits.

CHEMICAL ENGINEERS AND CONSULTANTS ON ALL WATER PROBLEMS

BETZ

PROBLEM: How would you...

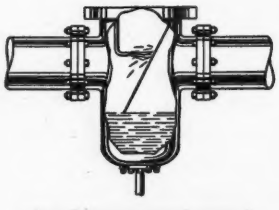
? Drain steam separators *ahead* and oil separators *after* reciprocating engine where pulsations tend to "bounce" buckets of inverted type traps, causing rapid wear, loss of steam and high maintenance.



STEAM ENGINES

Open bucket traps are not affected by pulsations and operate only when sufficient condensate reaches trap.

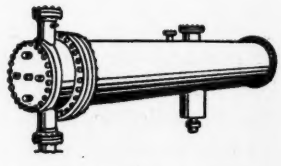
? Drain desuperheater where trap must draw off excess water though volume varies greatly with the fluctuating demand.



DESUPERHEATERS

Open bucket traps may be selected to provide generous capacity for peak load without danger of losing water seal under minimum load.

? Drain heat exchanger using low initial pressures and where throttling by thermostatic control valve causes wide pressure variations.

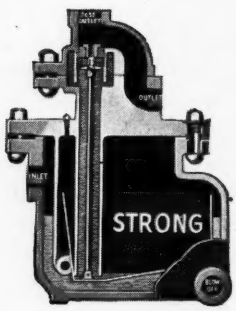


HEAT EXCHANGERS

(Water Heaters, etc.)

Open bucket traps are positive acting under low pressures and fluctuating pressures resulting from use of thermostatic or throttling controls.

HERE'S STRONG'S SUGGESTION



NOTE: Inverted bucket traps or special float traps are recommended on desuperheaters and heat exchangers under certain conditions.

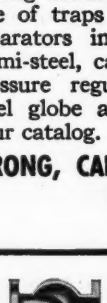
Why we can recommend the best trap for each job!

Conditions may suggest open bucket traps on your job . . . or . . . inverted bucket traps, closed float traps, float and thermostatic traps . . . semi-steel, cast steel, forged or welded construction. To enable you to get the most out of your steam, Strong engineers are at your service with years of experience in all types of installations and a complete line of equipment enabling them to recommend the size and type best suited for your needs.

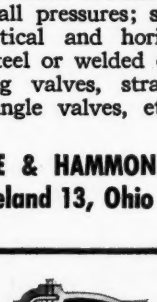
Strong Steam Specialties include: A complete line of traps for all pressures; steam and oil separators in vertical and horizontal types (semi-steel, cast steel or welded construction); pressure regulating valves, strainers, forged steel globe and angle valves, etc. Write for your catalog.

STRONG, CARLISLE & HAMMOND COMPANY
Cleveland 13, Ohio

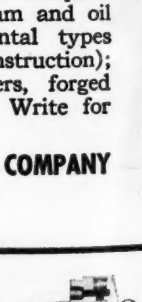
OTHER STRONG STEAM SPECIALTIES



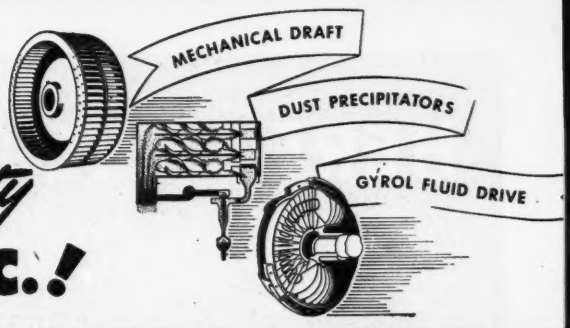
Separator



No. 70—Series Trap

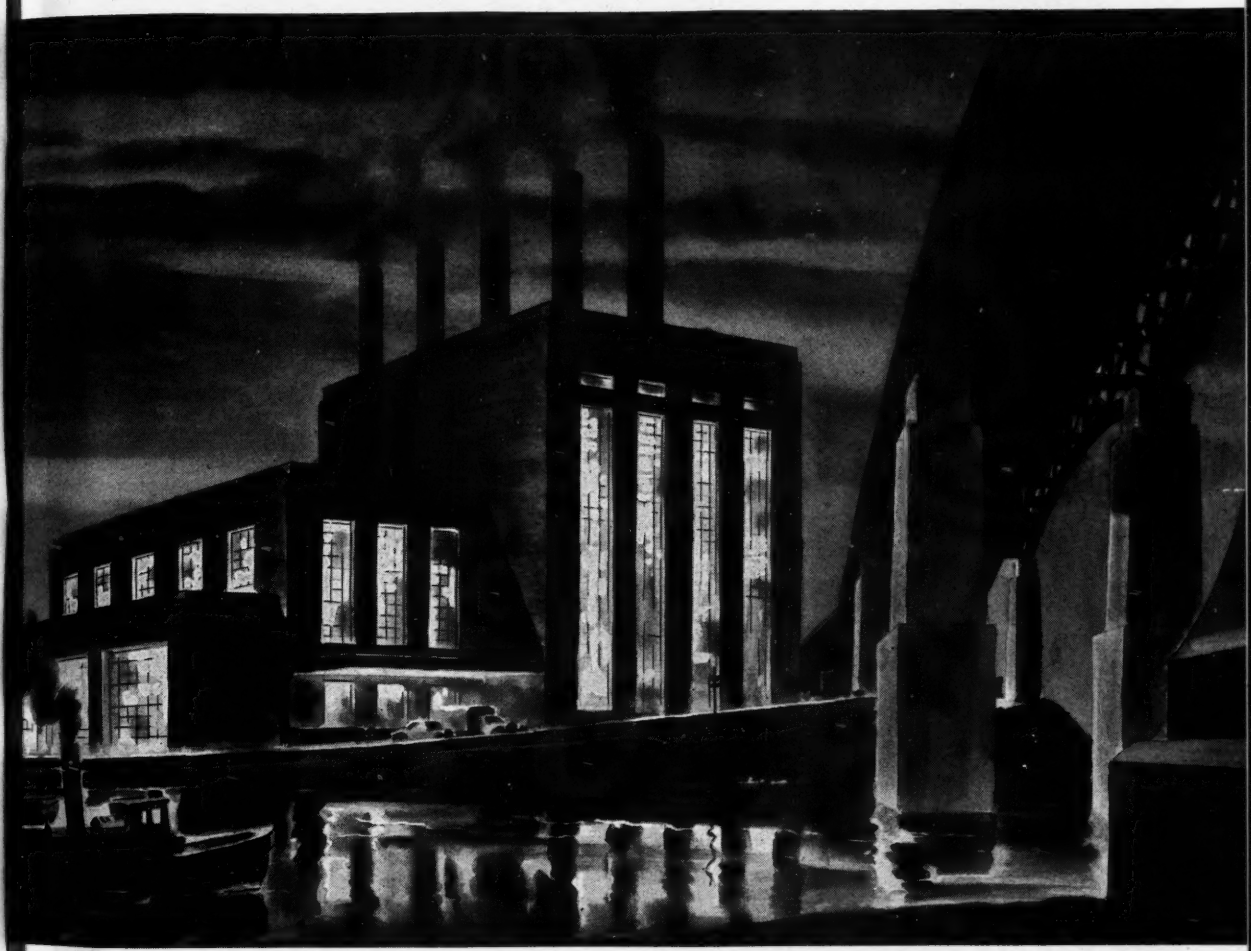


No. 80—Series Trap



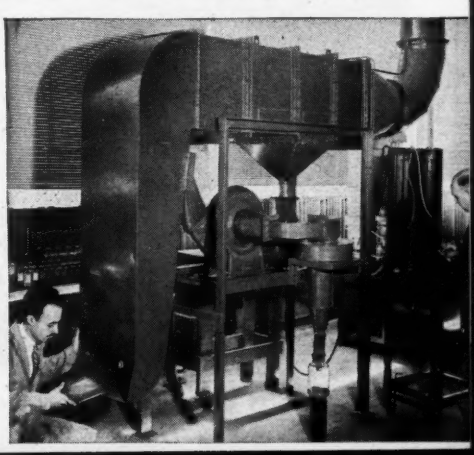
for undivided responsibility

Buy all 3 from A.B.C.!



Whether you're planning a new power plant or going to modernize your present one, you can get undivided responsibility by buying all 3—Mechanical Draft Fans, Dust Precipitators, and Gyrol Fluid Drives—from American Blower. By securing all 3 from A.B.C., you have one source of technical information and far less red tape. Try it! Call in an American Blower representative.

SEND YOUR FLY ASH PROBLEMS TO HEADQUARTERS. We will run tests, determine the equipment best suited to your individual needs, and work with your engineers in the application of time-proved American Blower Dust Precipitators to your plant or problem. A part of our Dust Laboratory, one of the largest and finest in the industry, is shown on right. Here, in the last 20 years, we have run tests on more than 4100 distinctly different materials. Every Dust Precipitator and Dust Collector we sell is built entirely in our own plants. Your inquiries are invited. Phone or write the nearest American Blower Branch Office today.



AMERICAN BLOWER

AMERICAN BLOWER CORPORATION, DETROIT, MICHIGAN
CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONTARIO

Division of American Radiator & Standard Sanitary Corporation

HERE'S THE "Tiffany" OF High TEMPERATURE – High PRESSURE PACKING

Core: Vulcanized pure asbestos fibers, thoroughly graphitized.

Braided Asbestos Jacket: reinforced with monel wire.

JOHN CRANE Style 6-AM

Large steel plant, Youngstown, Ohio:
"6-AM installed in open hearth valves. No difficulty."

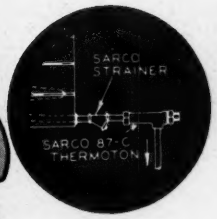
Cleveland steel mill:
"Open hearth valves still packed after 9 months. Exceptional service."

Large high-pressure power plant, Painsville, Ohio:
"Excellent service with steam on stop valves at 2000 p.s.i., 650° F. and superheated 300°. Have standardized on 6-AM."

Operating Engineers: Order spirals, coils, spools, die-formed rings or sets.

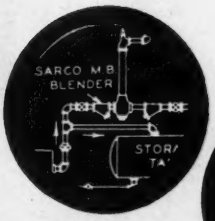
CRANE PACKING COMPANY

1812 CUYLER AVENUE • CHICAGO 13, ILLINOIS



Strainer

Controlling cooling coil



Blender on showers

Controlling solvent still

at the TWIST *of a* WRIST

Whenever a steam fitter breaks a line and inserts a Sarco strainer, a steam trap or a temperature control, he makes a permanent contribution to the efficiency of that part of the plant. Increased output of the steam equipment, dependable operation, increased quality of the product and the fuel savings that invariably follow will go on for years as a result of an hour's work.

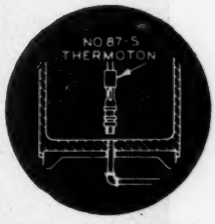
IT'S TIME TO CONSIDER

Steam helped the war effort, but steam *economy* will be necessary for industrial survival in peace. All over the plant, you will find spots where the man with the wrench can easily insert inexpensive Sarco Steam Savers that were overlooked or not available at the time.

HOW TO BEGIN

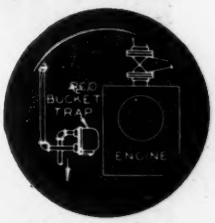
Easy does it. Call in the Sarco representative for a re-check on your steam engineering. Order a supply of the traps you need. Then, during shut-downs or long week-ends, the man with the wrench can slip them in. Before you realize it, your plant will be on the way to post-war competitive efficiency.

Then you can go after the temperature controls and some of the applications which are suggested in the circles above.

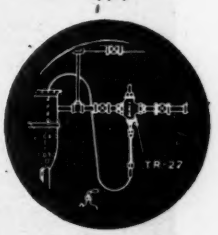


Heating water with 87-S

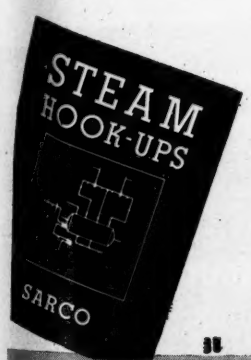
FT trap on cooker



Bucket trap on engine supply



TR-22 control on Kettle

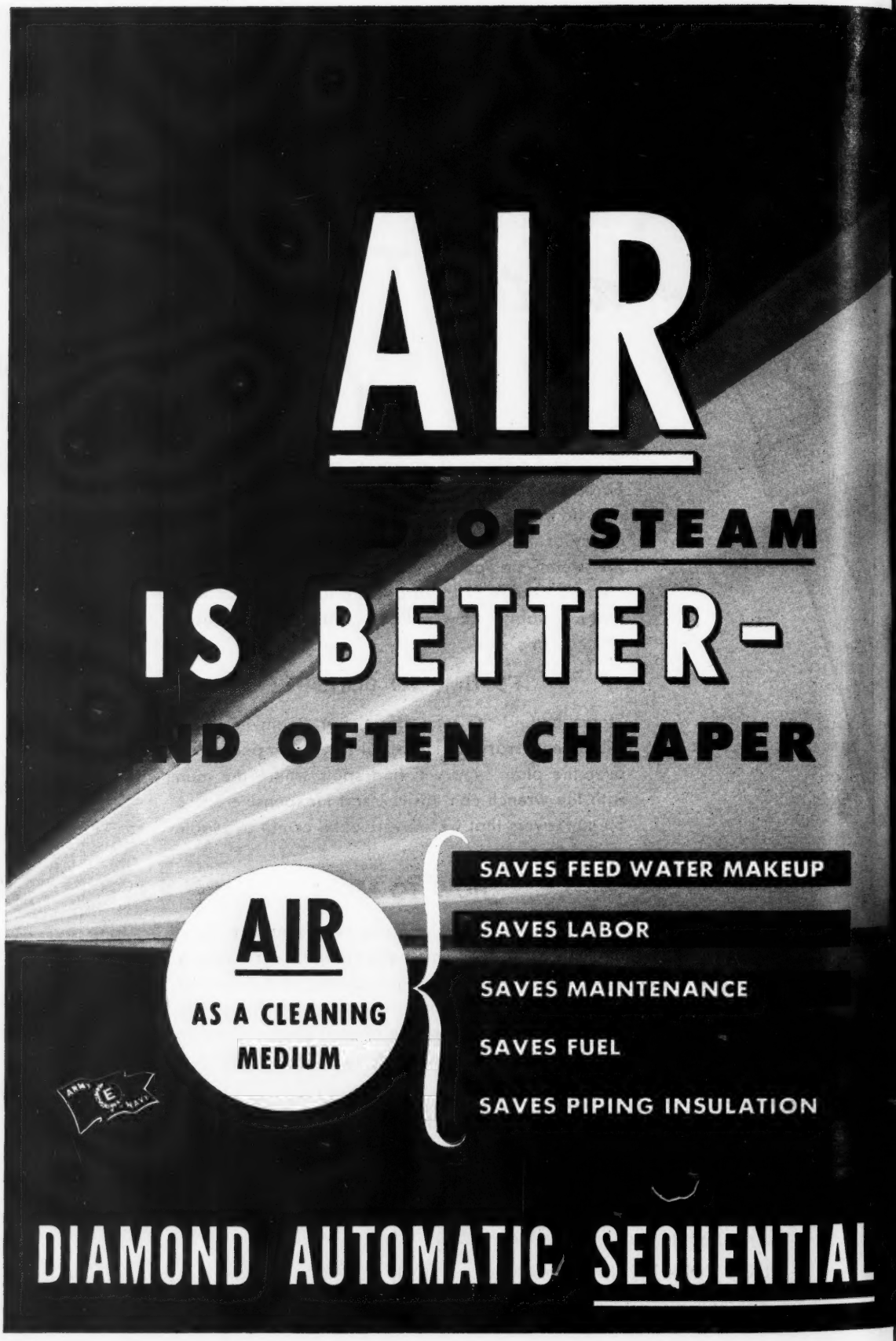


SARCO COMPANY, INC.
475 FIFTH AVENUE
NEW YORK 17, N. Y.

Represented in Principal Cities

SARCO Saves Steam

SARCO CANADA, LTD., 85 Richmond Street, West, TORONTO, ONTARIO


AIR
OF STEAM
IS BETTER-
ND OFTEN CHEAPER
AIR
AS A CLEANING
MEDIUM
SAVES FEED WATER MAKEUP
SAVES LABOR
SAVES MAINTENANCE
SAVES FUEL
SAVES PIPING INSULATION
DIAMOND AUTOMATIC SEQUENTIAL

...ondensate loss due to soot blowing ... compressed air instead of steam as the cleaning medium, with the Diamond Automatic Sequential Air System. This is a particularly important feature where feed water makeup is a problem. And having a greater density than steam, compressed air provides better cleaning.

The air is discharged from permanently installed elements (see below) in a series of short puffs with substantial pauses between. Spreading the cleaning cycle over a longer period of time eliminates stack discharge nuisance and permits use of a much smaller compressor.

The "human element" is entirely eliminated from soot blowing by the Diamond automatic sequential system which assures the positive operation of each blower unit in correct sequence and at the right speed every time.

No blower unit can be overlooked or incorrectly operated by a careless operator. All soot blower units on the boiler, superheater, economizer, and air heater are controlled from a single panel (see below).

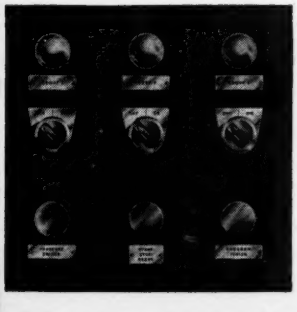
Labor is saved because no attendant is needed to drain the piping, warm it up and then operate each individual blower unit. Experience gained during several years' operation on a number of installations proves that maintenance costs are unusually low and that air blowing requires only ⅓ to ⅔ of the energy from the coal pile that is needed for steam blowing.

The Diamond Automatic Sequential Air Soot Blower System has been in successful central station use on boilers as large as 900,000 lb/hr units since 1940. For further information ask for Bulletin No. 956.

DIAMOND POWER SPECIALTY CORPORATION

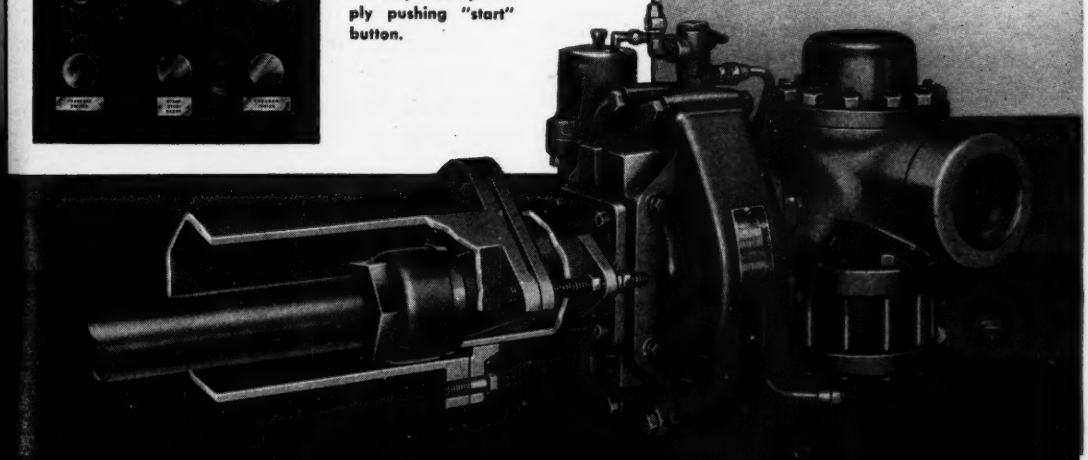
Detroit 31, Michigan

Diamond Specialty Limited • Windsor, Ontario



Program panel at left controls both fixed and retracting blowers arranged in three groups; any desired number of groups can be had when system is designed. Entire soot blowing system is operated in correct sequence by simply pushing "start" button.

Shown below is the Diamond Air Puff Soot Blower having element permanently installed inside the setting; various types of retracting soot blowers are also used in the Diamond Automatic Sequential Air Soot Blower System.



Air SOOT BLOWER SYSTEM

The turbine blades were pitted

Serious corrosion developed in a turbine in a New York brewery. A private water consultant and a consulting engineer both laid the blame on chloride in the boiler water, claiming that this was carried over into the turbine with the steam. They were forced to this conclusion because they *took it for granted that the corrosion occurred during the operation of the turbine.*

Hall engineers, however, had tested the steam and found no carryover of chloride, *so they knew that corrosion occurred during stand-by.* Examination had showed considerable moisture in the turbine during stand-by condition.

A check for possible sources of moisture revealed evidence of leakage of 400 lb. steam and of 60 lb. steam, but the major source was found elsewhere. The leak-off connections on the carbon seal rings drained to the barometric condenser hotwell. The end of the drain was well below the surface of the salt water in the hotwell, and there was no check valve in the line.

Thus, every time the turbine was shut down, hot salt water was siphoned back into it.

These conditions were readily corrected, the turbine was kept dry during stand-by, and the trouble stopped.

The alternative proposal, based on the assumption of chloride carryover, called for the installation of an evaporator to supply the whole system with distilled water — a procedure which would have been both expensive and ineffective.

Hall service engineers take nothing for granted. They *check all factors involved in boiler performance* and, in the event of trouble, trace that trouble down to its source.

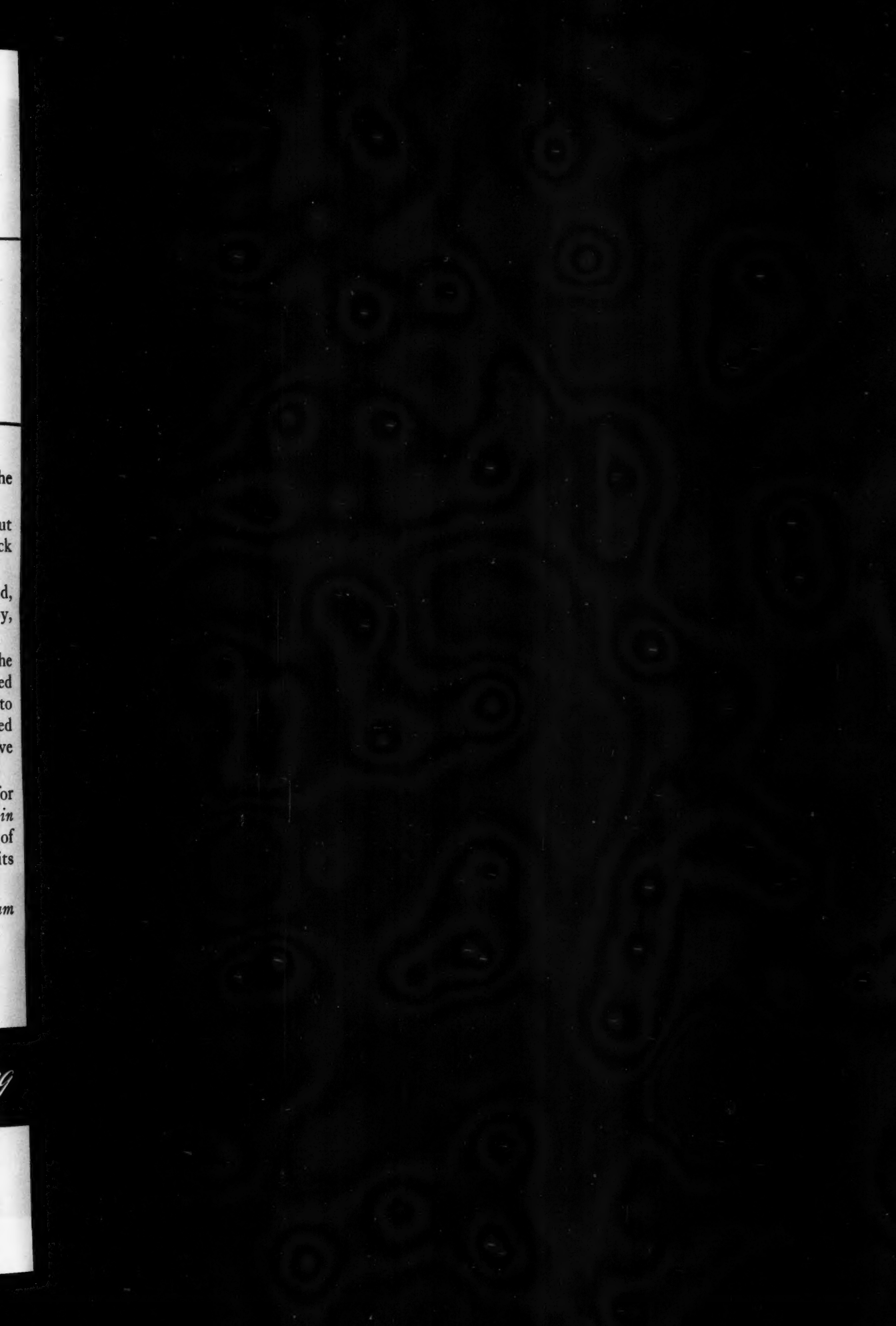
Every plant that generates its own steam power can profitably use Hall Service.

Write us for full information.

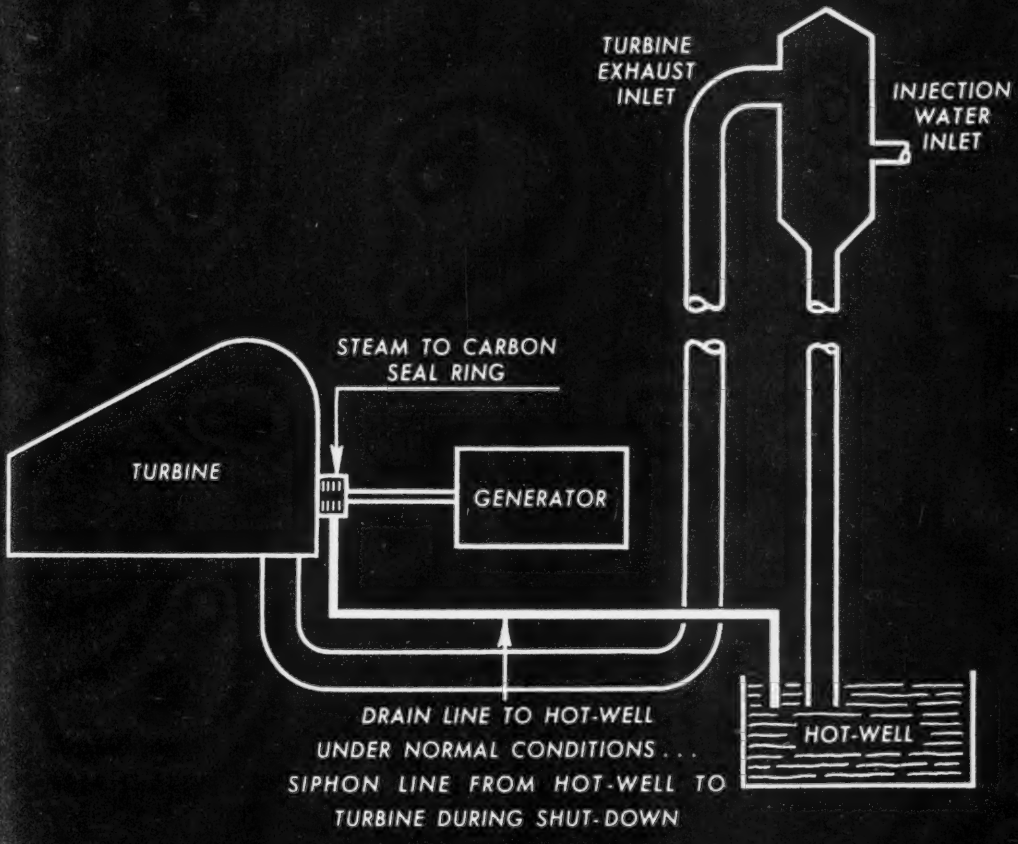
HALL SYSTEM *of Boiler Water Conditioning*

HALL LABORATORIES, INC. · HAGAN BUILDING · PITTSBURGH 30, PA.

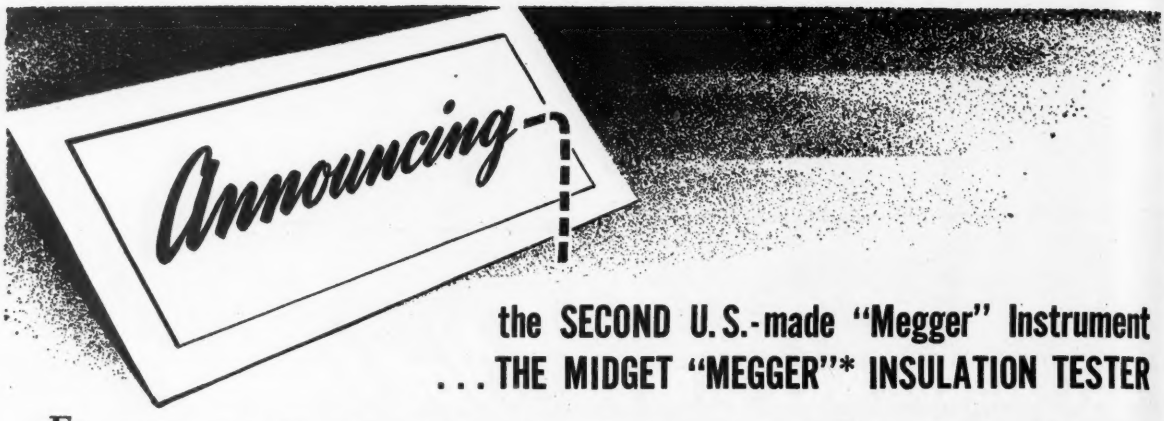
A subsidiary of Hagan Corporation



but steam was proved *"Not Guilty"*


TURBINE EXHAUST INLET
INJECTION WATER INLET
STEAM TO CARBON SEAL RING
TURBINE
GENERATOR
DRAIN LINE TO HOT-WELL UNDER NORMAL CONDITIONS . . . SIPHON LINE FROM HOT-WELL TO TURBINE DURING SHUT-DOWN
HOT-WELL

HAGAN HALL BUROMIN CALGON



the SECOND U.S.-made "Megger" Instrument ... THE MIDGET "MEGGER"* INSULATION TESTER

Following the production, in June 1943, of the first U. S.-made "Megger" testers, we now announce a second "Megger" instrument being built in our Philadelphia factory—the Midget "Megger" Insulation Tester.

This new U. S. model is identical in design and similar in every way to the Midget "Megger" Insulation Testers we have been supplying for the past ten years, except that the molded plastic housing is mottled brown instead of red.

The Midget "Megger" Tester has achieved wide popularity because of its size and low cost. Weighing but 3 pounds, it is always ready to use for testing insulation resistance of a wide variety of electrical equipment. It is indispensable for maintenance and trouble shooting, even where higher range "Megger" testers can be used . . . reads up to 50 megohms and delivers 500 volts d-c from a hand-cranked generator, making it independent of batteries or external power supply. Lower ratings are also available.

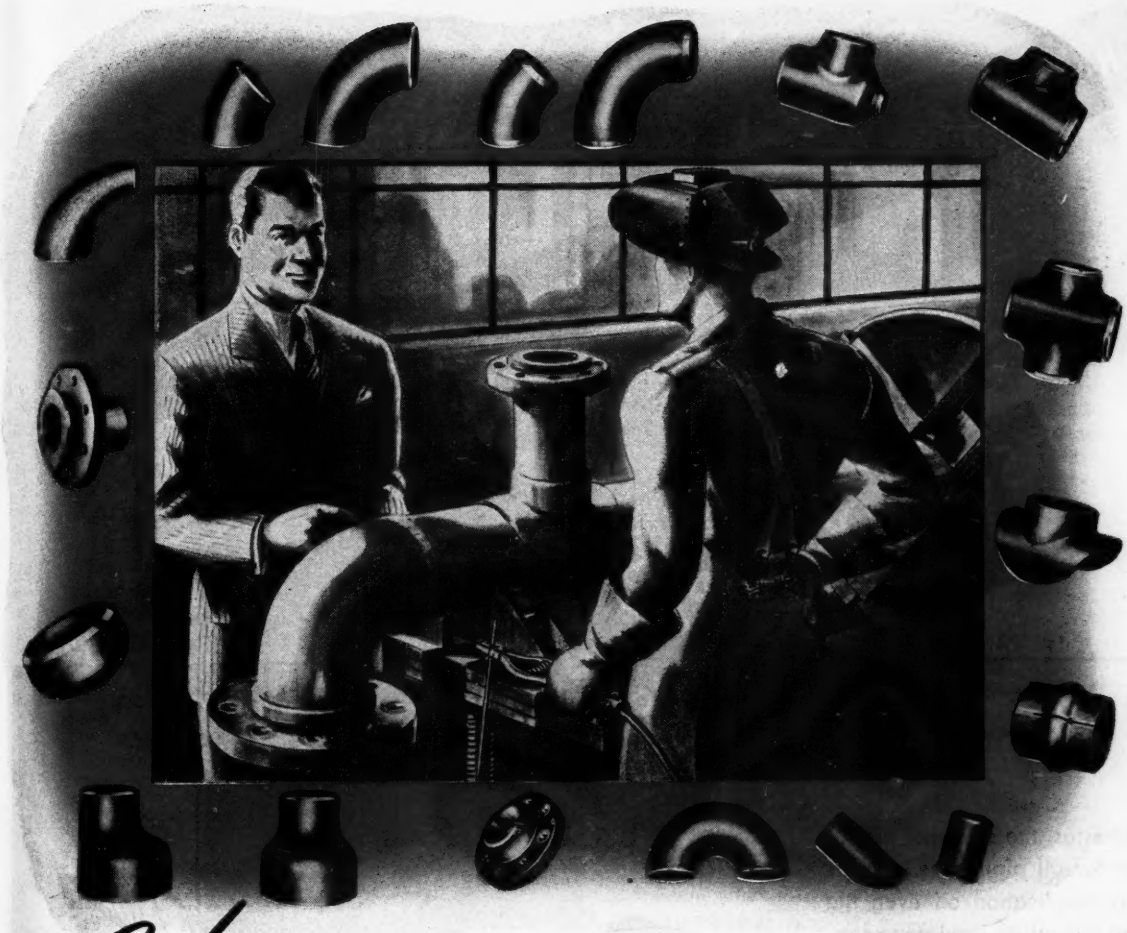
Manufacturing facilities are complete and our expanding production makes availability of these new instruments far better than we have previously been able to offer. We invite your orders for them.

JAMES G. BIDDLE CO.

1211-13 ARCH STREET · PHILADELPHIA 7, PA.

For complete description of the new U. S.-made Midget "Megger" Tester, write for Bulletin 1785-PE.

**By special arrangement with the original makers of the "Megger" Testing Sets, our new instrument carries the U. S. Registered Trade Mark "MEGGER."*



Ask **THE WELDER OF PRESSURE PIPING**

what he thinks of

MIDWEST WELDING FITTINGS

You will find that he gives them hearty approval. Piping welders generally have a high appreciation of the exceptional dimensional accuracy and uniformity of Midwest Welding Fittings . . . their job is easier and they can turn out better work faster.

Midwest Welding Fittings have extraordinary dimensional accuracy because particular precautions are taken in their manufacture. Midwest Welding Elbows, for example, are made slightly oversized, then reheated to forging temperature and given a final accurate sizing in compression. This provides accurate dimensions, true circular section, and uniform wall thickness. Comparative corrosion tests as well as tensile and ductility tests have proved the beneficial effect of forging the metal in compression.

Welders also appreciate the wide variety of Midwest Welding Fittings . . . including "Long Tangent" elbows and reducing elbows. There is a fitting for practically every condition he encounters. Ask the local distributor or our nearest office for Bulletin WF-41.

MIDWEST

PIPING & SUPPLY COMPANY, INC.

Main Office: 1450 South Second St., St. Louis 4, Mo.

Sales Offices: New York 7—30 Church St. • Chicago 3—645 Marquette Bldg. • Los Angeles 33—820 Anderson St. • Houston 2—[illegible] Shell Bldg. • Tulsa 3—533 Mayo Bldg. • Atlanta 3—Red Rock Bldg. • South Boston 27—436 First St. • Distributors in Many Cities

HAVING TROUBLE INSULATING BENDS?

SIMPLY APPLY UNIBESTOS
it's simple to apply!

Unibestos, the sectional insulation for all pipe sizes, permits easy application on even the most difficult-to-insulate expansion bends. Makes a clean, neat job. Unibestos is available in half-section form up to 30" pipe diameter and in quarter-sections from 32" to 60", in thicknesses from ¾" to 5". Available in single layer construction for service up to 1200°.

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MEANS PROGRESS IN INSULATION
AND RUBBER CO.

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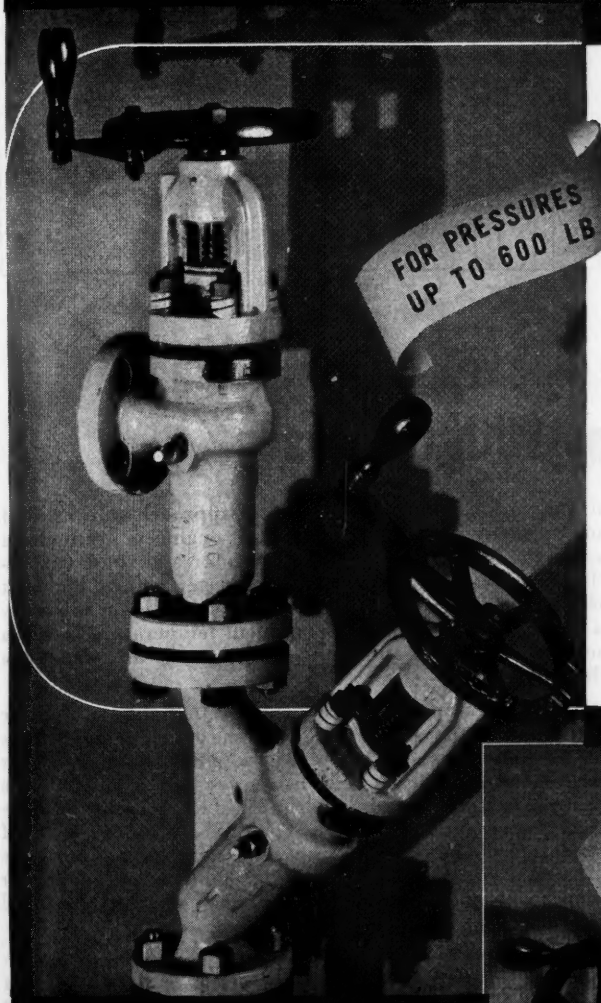
PLANTS: 1821 S. 54th AVE., CICERO, ILL.
PATERSON, N. J. • BLUE ISLAND, ILL.
OFFICES: CHICAGO • NEW YORK
SAN FRANCISCO • PATERSON, N. J.

A Blow-off Valve Service FOR ALL INDUSTRY



Nearly 40 years of laboratory and field experience, and continuous mechanical and metallurgical research, concentrated on the Blow-Off Valve requirements of power plants of all sizes, pressures and operating practices—have produced the Yarway *Seatless*-Tandem and *Unit*-Tandem Valves—the overwhelming preference of steam plant operators, today.

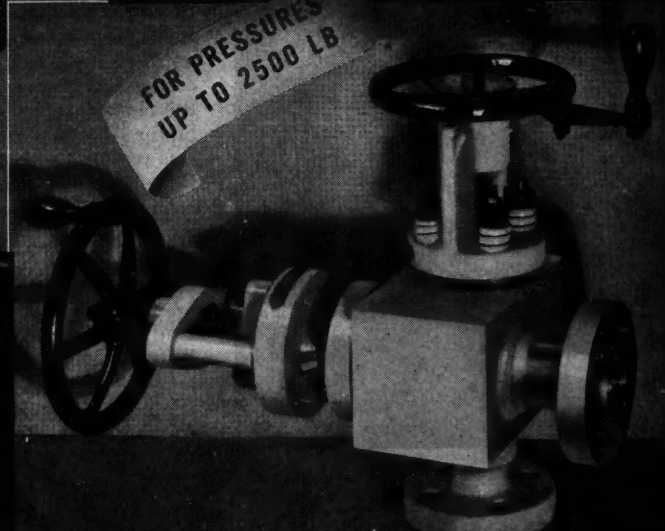
In fact, among the higher-pressure, pacesetting plants which have been built during the past ten years, it is the exception that is not Yarway-equipped.

When you plan a new plant or an extension—remember that your capital investment in major equipment warrants your insistence on the finest auxiliaries to protect that investment. And if you do, your natural Blow-Off Valve selection will be Yarway—the nation's choice.

Write for Catalog: Section B-432 for pressures up to 2500 lb; Section B-424 for lower pressures.

Ask about the new Yarway color and sound motion picture, available for group showings.

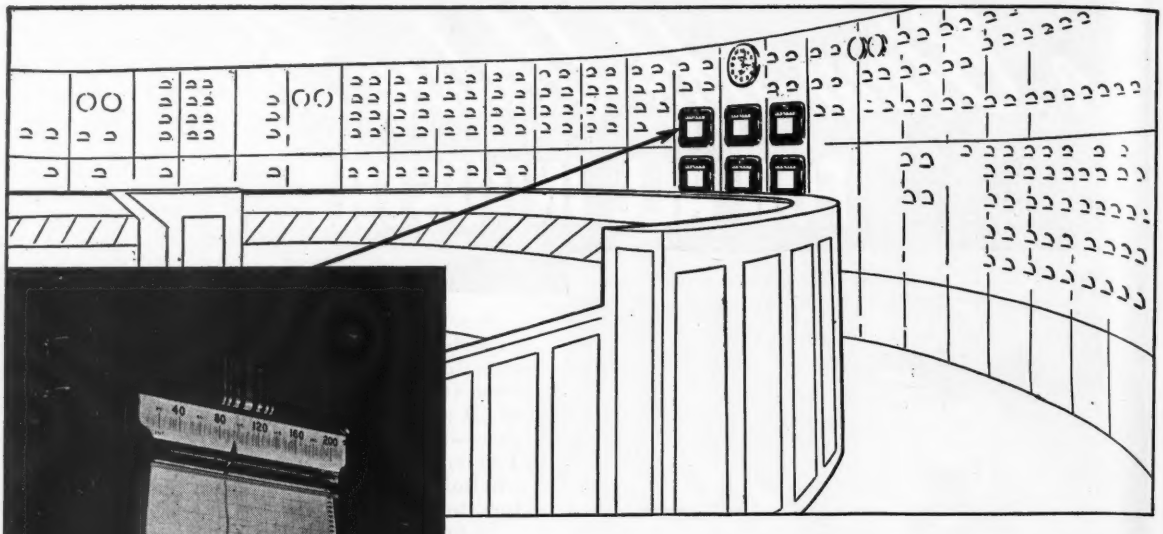
YARNALL-WARING CO. 114 Mermaid Ave., Phila. 18, Pa.

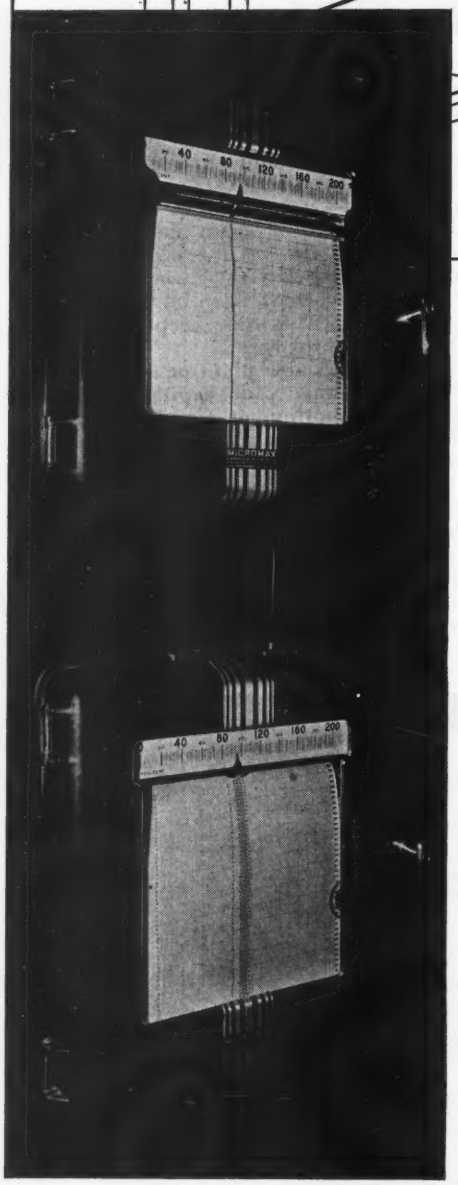


Yarway *Seatless*-Tandem with no seat to score, wear, leak. Standard in over 12,000 plants. Ideal for service where high concentrations are encountered and on pressures up to 600 psi.

Yarway *Unit*-Tandem equally suited for blowing or draining and for sealing on highest pressure service. Combines a Hard-Seat (blowing) and Seatless (sealing) Valve in a single, rugged, one-piece, forged steel body. For pressures up to 2500 psi.

YARWAY BLOW-OFF VALVES





The Record of a Micromax Helps With Overloads

When war work causes big generators to approach an overloaded condition (as many now do) the operating engineers are finding a new use for the Micromax Recorders of stator and rotor temperatures. They are watching temperature as never before, because it is temperature which eventually limits the load piled on a machine. When a change in power factor or ambient temperature permits a load increase, the stator and rotor temperatures are watched to say . . . how much!

Because a generator's field may change in temperature more rapidly than does the stator, the Micromax Field Temperature Recorder is sometimes a more sensitive guide than the Stator Recorder, especially under conditions of poor power factor. When a difference exists, it is accentuated by the fact that the Field Recorder is a single-point instrument, giving a continuous record of the temperature of the entire rotating mass of copper, whereas the Stator Recorder measures 8 points, so that none is continuous. For this reason, the Field Recorder may be more frequently consulted in routine operation.

The fact that the stator temperature does move more deliberately, however, makes many engineers prefer it as an operating guide, and complete protection against overheating requires that both field and stator recorders be the "insurance policy." They are equipped for signal lights and horn or bell, and stand always ready to give overall protection to generators, whether they be heavily loaded or overheated by accident.

Both of these Micromax Recorders are described in Catalog N-33-161, "Micromax Temperature Instruments for Electric Power Equipment," which is sent on request.

Jrl. Ad. N-33-161(6)

LEEDS & NORTHRUP COMPANY, 4973 STENTON AVE., PHILA. 44, PA.

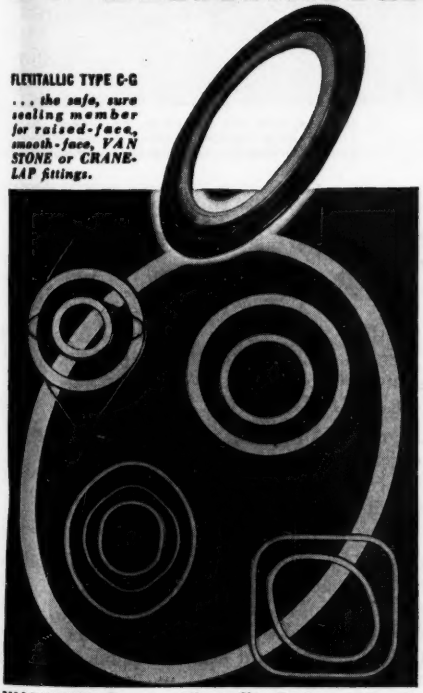
LEEDS & NORTHRUP

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

V depends on me!
A Slogan For Every American

SAVE MONEY ON GASKETS

BY ELIMINATING GASKET MAINTENANCE



FLEXITALLIC TYPE C-G *. . . the safe, sure sealing member for raised-face, smooth-face, VAN STONE or CRANE-LAP fittings.*

WARNING! *Genuine Flexitallic Gaskets are made only by the Flexitallic Gasket Company and are plainly identified by trademark. Specify them by name! This is your assurance of getting the only original spiral wound gasket, improved and perfected through 33 years of use in the toughest high-pressure sealing jobs in the world.*

Install Flexitallic spiral-wound Gaskets and forget your liquid, vapor, or chemical high-pressure sealing problems for a long time to come. Forget costly maintenance. Forget the possibility of leakage, bolt fatigue and similar troubles resulting from vibration, or service shocks, expansion and contraction. ***Seal flanged joints and pressure vessels the Flexitallic way—and they stay sealed!***

The entire 33-year record of Flexitallic success is simply one instance after another of proving beyond all doubt that Flexitallic Gaskets seal tight and seal permanently where other gaskets fail. Although, for several years past, the entire, greatly expanded production of Flexitallic Gaskets has gone for highest priority war needs, Flexitallic engineers welcome the opportunity now to acquaint you fully with the advantages of this safe, sure sealing method for all flanged joints.

FLEXITALLIC GASKET COMPANY
8th & BAILEY STREETS • CAMDEN, NEW JERSEY

"Flexitallic"
REG. U. S. PAT. OFFICE

SAFE, SURE SEALING FOR ALL FLANGED JOINTS

Designed, built and erected by Byrne Doors, Inc., Detroit. Apac Sheathing installed by the Faulkner Construction Company. (Official U. S. Navy photograph.)

. . . and SAFE because it's sheathed with "Century" APAC

THE striking architecture of this Navy Blimp hangar is its own tribute! The doors are like skyscrapers . . . 120 feet high . . . 220 feet wide . . . weighing 300 tons. And they must open the entire width of the hangar in TWO MINUTES.

These giant portals must be the masters of wind and weather—for failure to open and close quickly might spell the doom of a wind-tossed Blimp. So they are completely sheathed with "Century" Apac—K&M's low cost asbestos-cement sheet material. It is rot-proof, rust-proof and fire-resistant.

Check these "Century" APAC advantages for construction and renovation work

1. Made of Asbestos Fibre and Portland Cement
2. Pleasing light gray color
3. Fire resistant and durable
4. Convenient size—4' x 8', 4' x 9' and 4' x 10'. (Three thicknesses—3/16", 1/4" and 3/8".)
5. Low cost
6. Rat and termite proof
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Enormous quantities of "Century" Apac have gone into wartime jobs. YET NOW THERE'S PLENTY AVAILABLE FOR YOUR INDUSTRIAL CONSTRUCTION WORK . . . without delay, without restrictions.

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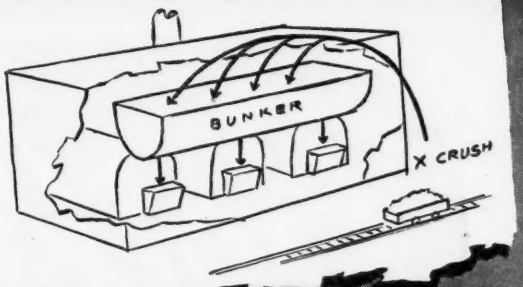
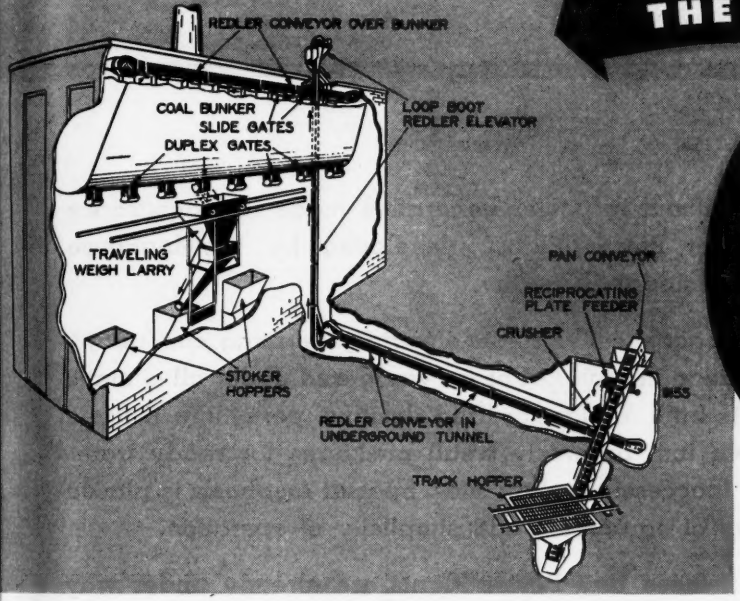
Handle Coal through 7 operations!
unload – crush – convey – elevate – store – reclaim – weigh



THE S-A ANSWER

Cut Handling Costs *At Every Stage*



Diagrammatic view of the S-A Coal Handling System at centralized boiler plant. Track Hopper, Pan Conveyor, Feeder, Crusher, REDLERS, Gates, Traveling Weigh Larry, are all designed and built by S-A.

View above coal bunker showing S-A REDLER Conveyor distributing coal full length of bunker. S-A Traveling Weigh Larry feeds coal from any part of bunker to any stoker hopper.

When a large state institution decided to centralize several boiler rooms into one power plant, it went all the way with a modern efficient handling system. Today, S-A equipment handles coal automatically through 7 operations.

This plant is a model of efficiency, low cost handling and cleanliness. The key to the solution is the system of REDLER Conveyors and Elevators. For REDLERS, using the *en masse* principle, require little space . . . having sealed casings, they eliminate dust and dirt.

Together with other S-A units, REDLERS make this an outstanding example of mechanical handling. Write for copy of REDLER Conveyor Catalog No. 140.

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Boilers for the

A NEW concept in power generation made its appearance with the "Unit Power Plant", developed by Westinghouse Electric International Company.

This compact effective steam-electric generating unit, adaptable to operation in any part of the world and under all climatic conditions, is built to standardized designs, permitting it to be broken down into relatively small packages for ready transportation to inaccessible plant sites. Special emphasis is placed on durability of equipment and simplicity of operation.

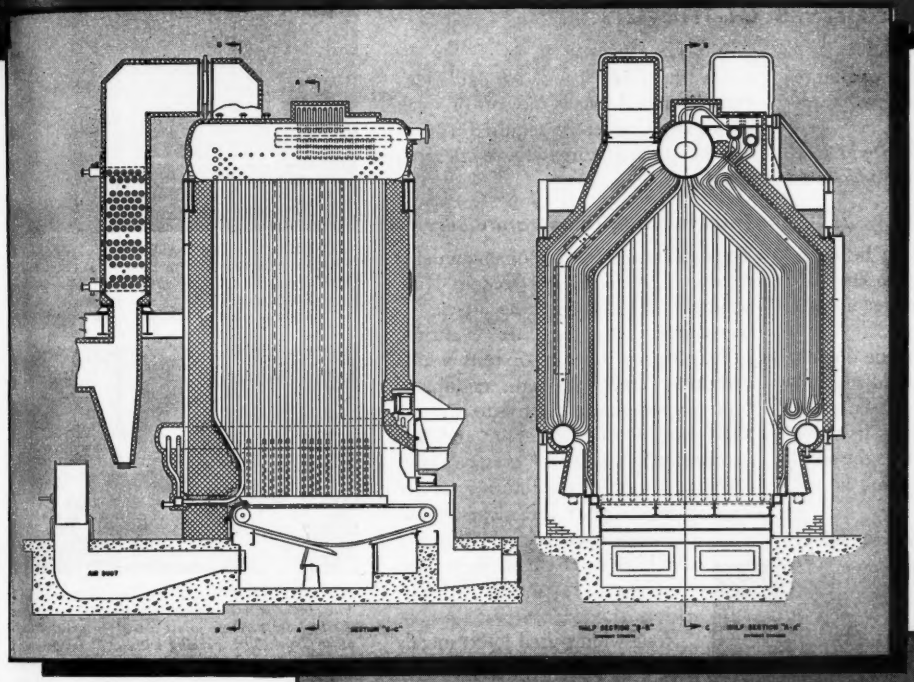
Many of these Unit Power Plants are already under way for China and Russia, for installation on the hot reaches of the upper Yangtze river to the arctic steppes of northern Siberia.

A study of the various boiler designs available for this severe duty led to the selection of Foster Wheeler type S-A steam generators for thirty-seven plants, the record showing that "all parties agreed upon this boiler as best adapted to meet the peculiar design, erection and operating conditions involved. Its compactness, freedom for unmasked refractories, adaptability to a variety of fuels, methods of firing and its free circulation influenced the selection."

FOSTER WHEELER CORPORATION, 165 BROADWAY, NEW YORK 6, N. Y.

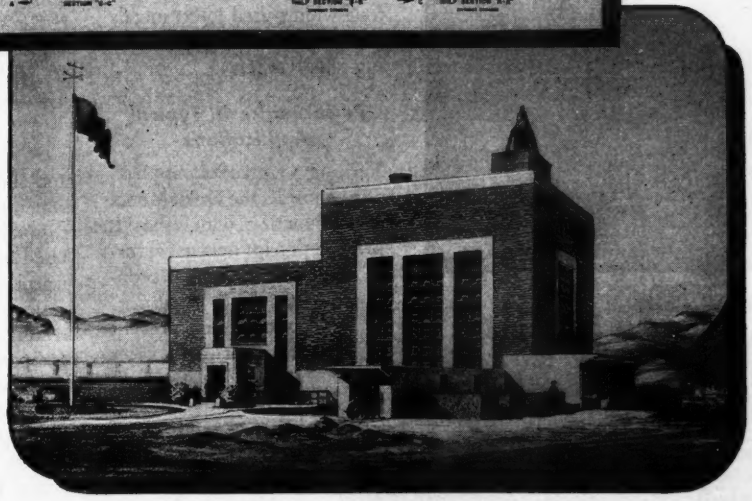
FW FOSTER W

UNIT POWER PLANTS



Sectional view of S-A type boiler destined for China.

Foster Wheeler is a four star winner under the U. S. Navy Board of Awards for production.



Architect's drawing of completed Russian Power Plant.

WHEELER

2000°
1500°
1000°
500°
0°

HIGH TEMPERATURES

...as they affect the properties and usefulness of metals

A metal's fitness for high-temperature use is usually measured by two yardsticks:

1. *Its continued resistance to oxidation*
2. *Its retention of strength and hardness*

Getting a good rating on one of the two counts isn't enough. To be thoroughly satisfactory for most heat resisting uses, a metal must get a high mark on both.

High original strength alone doesn't matter much if a metal oxidizes and scales, thus reducing in cross-section, or if intercrystalline change saps its vitality. Also, in many applications the scale that flakes off is a complicating factor.

On the other hand, an oxidation-resistant metal that is too soft or weak to stand up under its required load in the high temperature range is out from the start.

Tests for High-Temperature Service

The oxidation resistance of a material is measured in terms of freedom from scaling and intercrystalline attack. Its mechanical properties are evaluated principally by a series of tests which determine creep strength, endurance limit, impact strength, stress to rupture, short-time tensile strength, and hot hardness. All these seven characteristics together determine the limiting service temperature for a metal or alloy.

The INCO Nickel Alloys get a high mark on all these high temperature tests. The limiting service temperatures of four widely-used INCO metals are shown in the accompanying table (at left).

Limiting Service Temperatures—°F.

Material	Sulfur-free Atmospheres			Steam	Sulfurous Atmospheres			
					Temperature Below Which These Materials May Be Used**		Temperature Above Which These Materials Cannot Be Used	
	Oxidizing	Reducing H_2	Reducing CO		Oxidizing	Reducing	Oxidizing	Reducing
Monel	1000	2000	1500††	800	Up to 600‡	Up to 500‡	1000	650
Nickel	1900	2300	2100	900	Up to 600‡	Up to 500‡	1000	700
"D" Nickel	1650	2100	2100	‡	600	*	1000	‡
Inconel	2000	2100	2100	1100†	1500	1000	1500	1000

†† Estimated.

** These materials should not be used above the recommended minimum temperatures without consulting INCO.

‡ Monel is not recommended for use in contact with oxide-rich containing sulfur at temperatures above 500° F.

* No experience at higher temperatures.

‡ Insufficient creep data to date. Applications approaching upper temperature limit should be referred to The International Nickel Co., Inc., for specific recommendations.

† Inconel and "D" Nickel are superior to Monel at all temperatures.

The INCO Nickel Alloys get a high mark on all these high temperature tests. The limiting service temperatures of four widely-used INCO metals are shown in the accompanying table (at left).

Performance in Typical Applications

Turning to practical applications, consider the use of Monel in conjunction with asbestos in insulation for new naval turbines. Here, the problem was to "reinforce" asbestos and prevent its shivering to pieces from the incessant vibration of giant turbines operating at temperatures up to 850° F.

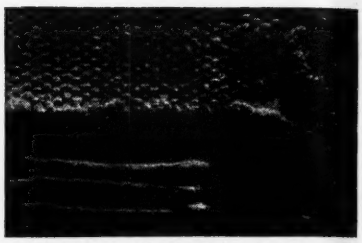
After experimentation, Johns-Manville engineers devised an asbestos yarn with a Monel core, made of 2 Monel wires .007" in diameter, twisted together. Woven into cloth, the asbestos-Monel combination provided durable insulation that withstands both sea-air corrosion and high temperatures.

Dynamic Hardness of Materials at Elevated Temperatures

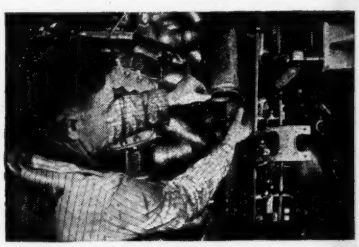
Material	Condition	Hardness Brinell Room Temperature	Dynamic Hardness* Temperature - F								Hours at 1200° F		
			Room	200	400	600	800	1000	1150	1200	2	6	26
Monel	Annealed	141	223		199	185	172		161	155	148	150	148
	Cold-drawn	207	341	315	270	241	231	204	188	179	172	166	159
"K" Monel	Age-hardened			385	354	322	315	311	311		264	256	241
Nickel	Annealed	116	202	241	174	156	140	148					
	Cold-drawn	212	314	314	280	274	243	229					
"Z" Nickel	Age-hardened	273	423	416	381	359	369						
Inconel	Annealed	172	270	261	254	241	227	219	221	216	192	199	202
	Cold-worked	298	502	504	427	505	416	388	385	388	314	287	287
Monel	As cast	114	264	245	261	229	207	196	191	190	180	179	172
"H" Monel	As cast	203	392	372	333	333	328	327					
"S" Monel	Soft	268	548	515	514	467	521		595	495	628	567	511
	Age-hardened	334	699		514	614	641	601	548	548	548	511	462
SAE 1020 Steel	Annealed	112	228	216	188	192	233	233	221	180†	235	176	174
SAE 1070 Steel	Annealed	161	292	272	255	221	215	243	261	256	221	193	212

† 1100° F.

* Data determined by a dynamic method of hot hardness measurement developed by the Company's research laboratory. By this method a combination of hardness and impact properties is measured on the heated specimen. The values are not directly convertible to Brinell numbers.



CLOSE-UP OF MONEL-ASBESTOS *cloth, devised by Johns-Manville, used to insulate naval turbines. Each thread consists of doubled .007" Monel wires, twisted with asbestos. Monel withstands corrosive sea air...incessant vibration...temperatures up to 850°F.*



INCONEL MESH PACKING *(sometimes combined with asbestos) was originally developed for sealing the high-temperature joints along the exhaust lines of airplanes. This packing withstands temperatures ranging up to 2,000° F., corrosive exhaust fumes and incessant vibration. Photo shows mechanic installing Inconel mesh packing in exhaust joint of a B-29 Superfortress. (Photo, courtesy of Boeing Aircraft Company.)*

* * *

A similar combination of asbestos and Inconel provides resilient packing which resists high temperature and corrosion by gases, alkalies, and most acids. Used now for packing exhaust lines of warplanes... where it forms a flexible cushion between vibrating joints while sealing in the white-hot gases... this composite packing offers designers and engineers high-temperature packings for possible use in post-war power installations.

You will find valuable information about High Temperatures and other properties of metals in the bulletin "The Technical Editor Speaks." For a copy, address:

THE INTERNATIONAL NICKEL COMPANY, INC.
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Sinclair OPALINE RP (Rust Preventing) OILS for enclosed oil systems, prevent internal rusting of engines, hydraulic systems, gear reducers, and similar machinery intermittently operated, stored, or transported. OPALINE RP also has ample lubricating qualities for temporary use.

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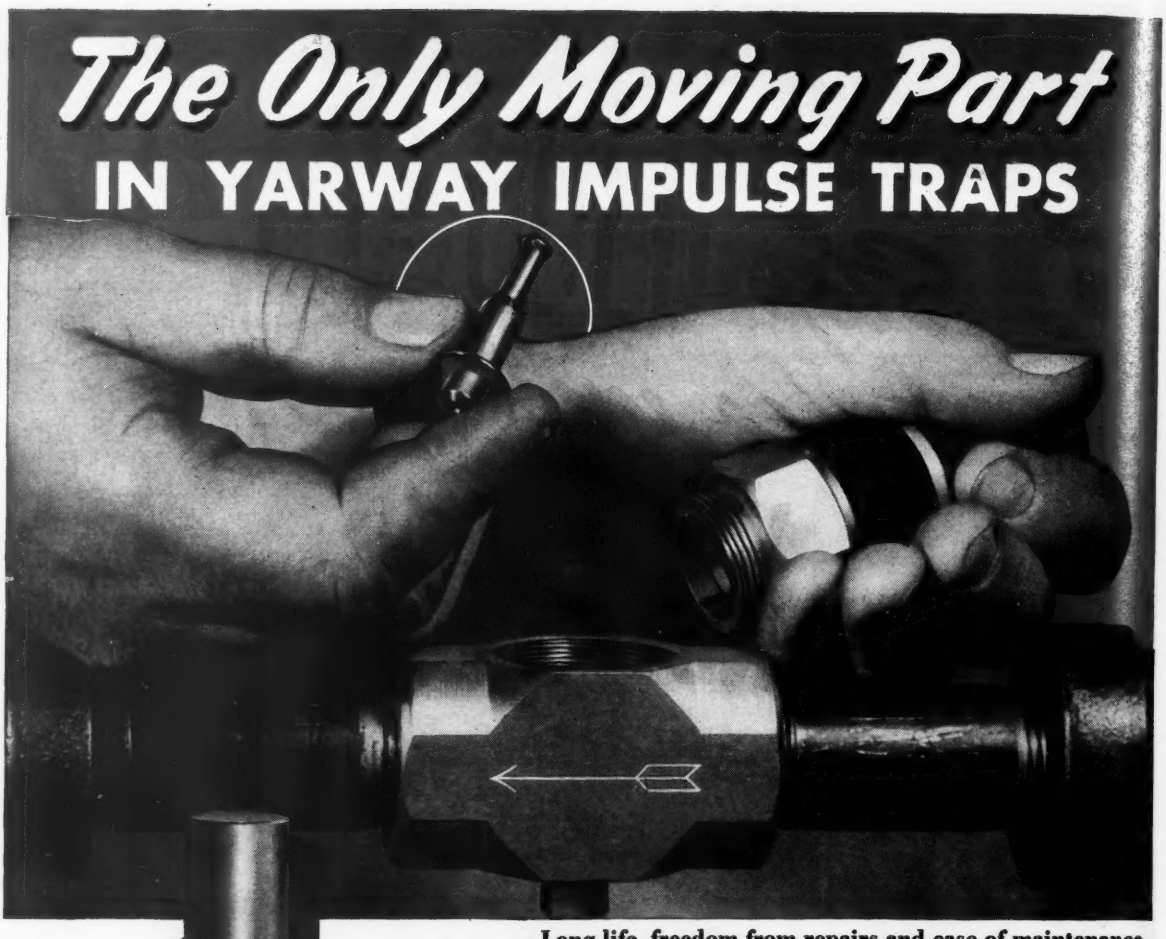
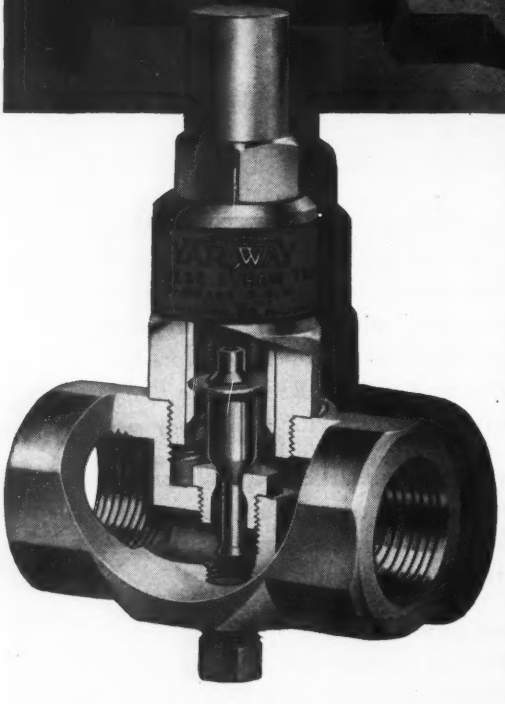
The Only Moving Part
IN YARWAY IMPULSE TRAPS





Long life, freedom from repairs and ease of maintenance are three good reasons why more than 400,000 Yarway Impulse Traps have been purchased in the few years since their introduction.

This simple valve—the only moving part—and its replaceable seat—are stainless steel, heat treated. They are good for all pressures.

After years of service, they may be replaced simply by removing the trap bonnet. No need to disconnect the trap from the line. And engineers tell us a handful of these parts will keep a plant full of Yarways in tip-top shape over the years. Far cry from the large inventory of repair parts needed to service other traps.

Maintenance is a major consideration in steam trap selection, of course, but *performance is paramount.* And that is where Yarways really shine. Their continuous discharge on heavy condensate loads gets equipment hotter, sooner, and their intermittent discharge on light loads keeps it hot for maximum operating efficiency, day in and day out.

And when you consider, too, it usually costs no more to install Yarway Impulse Traps than to repair other type traps, why not solve your steam trap problem with Yarways? Write for Bulletin T-1739 or see your mill supply distributor. (More than 100 leading dealers feature Yarways.)

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YARWAY IMPULSE STEAM TRAP

WHAT LEADERS SAY

Prospecting for Apparatus and Merchandise

By TOMLINSON FORT

LET'S suppose that, having been out of the market for some years, you are in the market today for some steam generating equipment. The Navy and Merchant Marine had an insatiable appetite for steam turbines and condensers during the past four years. Manufacturers of steam equipment are today putting out their products in a volume probably five times their heaviest previous rate. Only a trickle of their capacity is being allowed to go to the public utility industry. Most turbines being manufactured today are a single purpose specialty, largely high-speed turbines which are generally connected through reduction gears to propeller shafts. In horsepower, the annual output of steam turbines today could in a very few years equal the total horsepower of all the generating equipment in the utilities of this country.

The turbines which are being manufactured for the war program are not the tailor-made product normally sold to the central stations of this country. They are almost a semi-mass production product.

Very strangely, the electric generator manufacturers of the country are in quite a different situation from the steam equipment manufacturers. One big reason for this condition is that most of our ships are being driven by turbines connected to propeller shafts through reduction gears. Thus, most of the turbines made today do not need any generators. Next, the generator manufacturer did an enormous job early in the war building rectifiers for the aluminum and magnesium programs. This rectifier job is virtually completed. Next, the manufacture of generators for power generation is today on a very small scale.

Therefore, the generator manufacturers of the country which early in the war were producing at about twice their peacetime rate, have now lost a large part of their load. Their ability to handle business today is not limited by capacity or crowded schedules, but because the WPB is still very heavily restricting the manufacture of generating equipment.

To put out the large volume of switchgear manufactured last year, much of the technique of making switching equipment changed greatly. This is particularly true of switchboards. Large orders for switchboards have been placed by the Navy calling for many duplicates of the same equipment. This has enabled switchgear manufacturers to set up production lines and manufacture this type of equipment in quantities which were never before possible.

You will still have difficulty for a time in obtaining deliveries on this class of apparatus.

The construction programs of the early war years placed heavy loads on the manufacturers of power transformers. Production in this field went up close to 200 percent of prewar levels, but today, due to the virtual completion of the wartime construction program, power transformer manufacturers are in a situation comparable to that of the electric generator manufacturers.

The only bottleneck today in the transformer manufacturing industry is in the field of small distribution transformers largely used for rural electrification.

Watthour meters are a critical item in your industry today. This is true because the watthour meter manufacturers have had to give preference to the manufacture of instruments for the Army and Navy over all other orders. Immediately our wartime job is done we can be back to the prewar level of watthour meter manufacture in thirty days.

When the WPB allows us to again go back into production of appliances we feel it will require about four months to get material and start production. It will then take us one month to fabricate parts, and actual production of appliances will start within five or six months after clearance is received from the WPB. By going back into production on the basic designs of prewar, we will be accomplishing the best results for the consumer, as he will get quality, proved merchandise quickly—for the dealer and distributor for we will get him back into the appliance business with no risk of untried production.

The most important load of the public utility is still the lighting load. Immediately after the war many thousands of commercial establishments and industrial concerns over the country are going to convert to fluorescent lighting. It is important that the electrical industry be ready to use this opportunity to raise levels of illumination.

The production of high wattage lamps has doubled in certain ratings and tripled in others since the war began. This indicates to us that the industry generally is more conscious of the benefits of good lighting than has ever been the case before. Also, ninety percent of the lighting fixtures in commercial establishments are obsolete today. There will be a rush to replace these when the war is over.

You have a sizable backlog of delayed purchases. It is a serious concern on your part that perhaps at the time when you come back into the market you may step into a period of inflation and high prices.

However, there are things we can do which will help to keep prices down. Probably the least of these is continually yelling that labor costs must go down. One of the apparent paradoxes of wartime operation has been the fact that labor costs have gone up on an average of over 40 percent; material costs have also increased, and yet manufacturers have been able to produce many items of electrical apparatus at lower prices than before the war.

Overall costs have not gone up in proportion to increases in labor and material costs, due — first to greatly increased volume; second to continuous improvement in manufacturing processes, and third to concentration on standardized equipment. Prices after the war will, in a large measure, have to reflect not only labor and material costs, but these other three fundamental factors.

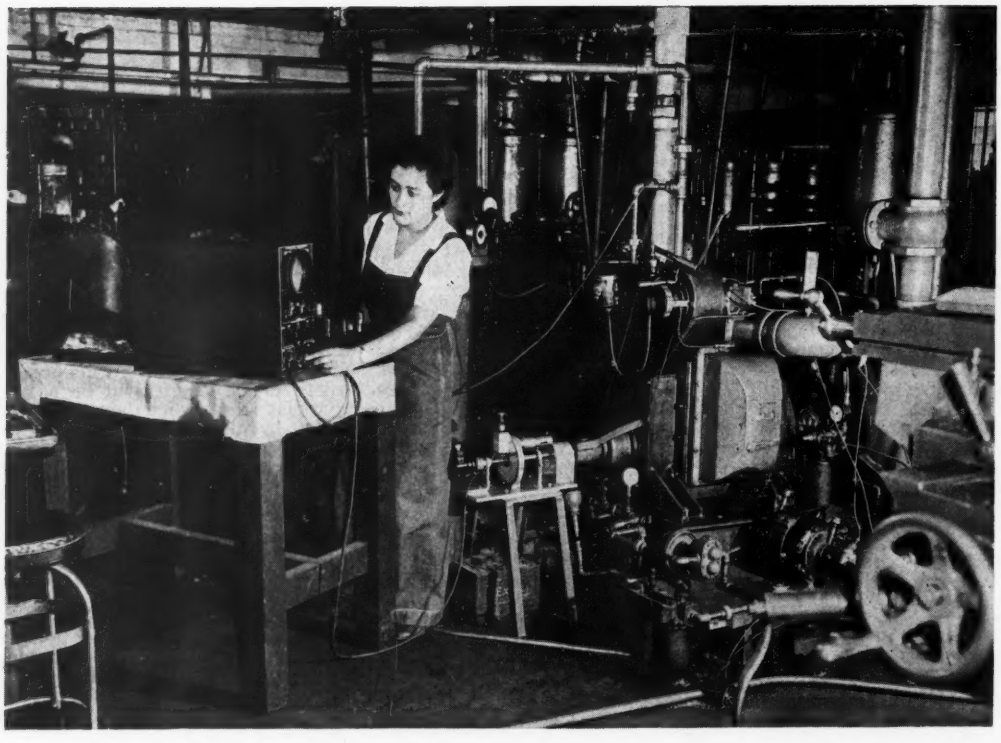
Let's see what can be done cooperatively about these three items of cost:

First—increased volume can only come by increasing the use of electric power. The utilities and the manufacturers must join hands to promote this in every way possible.

Second—improvement in the use of manufacturing facilities. This is a job for the manufacturers.

Third—the increased use of standardized equipment. By purchasing as much of your equipment as possible in accordance with standardized industry specifications, the economies of quantity production can be brought to many lines which heretofore have been individually manufactured.

Tomlinson Fort, Manager of the Central Station Department, Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., was born in Atlanta, Ga., in 1902. He attended Roswell High School in New Mexico and received his Bachelor of Science degree in Engineering at New Mexico A. & M. College. Soon after his graduation, Mr. Fort joined Westinghouse, after training at East Pittsburgh was assigned to headquarters sales until 1927, then was sent to Albany, N. Y. From 1931 until 1940 he was attached to the Westinghouse office in New York, then returned to East Pittsburgh as assistant manager of the Central Station Department and in 1943 was made manager. He is a member of the A.I.E.E. and author of several articles on turbines. The above article is taken from a talk prepared for delivery before the Public Utility Group of the National Association of Purchasing Agents on February 1. This meeting was cancelled.



America Gave Me Opportunity

Lidia Manson, young and pretty Russian-born engineer, a member of a development engineering team at Clark Bros. Company at Olean, N. Y., was the only woman speaker at the 49th Annual Meeting of the National Association of Manufacturers held in New York recently. In her address, Miss Manson lauded America for the opportunities it afforded her to continue her research in internal combustion engines. America, she pointed out is the world's greatest industrial nation because manufacturers are willing to foot the bills for research whether or not they can foresee any practical value in it. The photograph shows Miss Manson at work in the engineering laboratory at the Clark Bros. plant in Olean. Her address is presented below:

THERE was one big worry about America for me when I came to this country from France. That was whether I would have a chance to continue the career I had planned for and worked for since I was a child. I had started to do research in internal combustion engines and wanted to continue. America was not then at war. But we in Europe felt it coming, and the thing that worried me was that if war broke out, engineering jobs in this country would be closed to foreigners like myself.

Despite that worry I got a visa and finally reached New York—the day Germany invaded Russia. As a newcomer to the United States I was quite aware of my handicaps, the most striking of which were my English pronunciation and skirts in a profession that was traditionally masculine. But I had sound training, a few years' experience, and a great yearning for the engine noises I had missed during the year it took me to get to this country. So, banking on those things and a shortage of specialists that I knew would occur in wartime, I hoped that I would have a fighting chance to reach my goal.

However, there was one thing I hadn't counted on. And that was the American system. For instead of a fighting chance I found a wide open welcome. America gave me my opportunity.

In the United States much of the world's engineering research is done. That fact had been brought home to me before I ever left France, since about 60 per cent of the technical papers I usually read came from the United States. Even so, I had not realized what a vast research and development program this country had established. Not only do the big corporations have elaborate laboratories and tremendous staffs, but even most of the smaller manufacturers have development departments. Furthermore, American manufacturers help foot the bills for college and government research institutions. They do it to help the advancement of science. That's one of the beauties about America. You manufacturers are willing to pay for research whether you can see any immediate practical value in it or not. It's a sound policy, for industry is the ultimate beneficiary of all scientific research.

(Continued on page 130)

WITH THE EDITORS

Consulting Engineer's Function—One of the important functions of the consulting power engineer is to interpret power engineering to industrial management. The latter may have all kinds of knowledge and skill in production processes yet may acquire the strangest conceptions of how the power and steam for those processes should be produced.

Industrial management has an engineering skill of its own, yet it may often form opinions on power matters based on a great deal of wishful thinking, half-knowledge and factors of personal judgment, the latter being one of the most important and useful factors in its selling operations but not always applicable in deciding power questions. And it has even happened that incorrect executive thinking, based on generalities, has often over-ridden the plant engineers sound knowledge. If you doubt it, see The Chief, He Don't Know Nothin' About Engines, in the March issue.

But a consulting engineer often can counteract this incorrect thinking, confirm the soundness of the plant engineers' ideas and prevent the making of decisions that will saddle on those plant engineers equipment and methods that never will work right. That is one of a consulting engineer's prime functions and it is often exercised, we observe. Here is an illustration.

An interesting reaction one of our consulting engineer friends gets from the management executives of a number of industries is in regard to the generation of steam at high pressure and high temperatures. In some cases, he has found highly conservative companies (who for years had been almost reactionary in their attitude toward modern production techniques) calling vociferously for power plants generating very high pressure and high temperature steam, in relatively small installations.

For example, in one case, a 15,000-lb-per-hr steam generating unit was to be put in and the client kept insisting that this should be for 1250 psi, 900 F. The consulting engineer had a hard time convincing him that for this particular case such high pressure and temperature were not justified. The client's real reason for wanting them was that a leading utility company in his region had just installed a new 1250-psi station. They had the latest and best in power plants and the industrial company wasn't going to take second best in competition with them.

At the other extreme, this consulting engineer found a number of companies who would not listen to the generation of steam at high pressure and high temperature where it is justified and would improve economy, but insisted on sticking to HRT boilers operating at 150 psi for no other reason than that they had always had them, knew about them, and liked them.

We thought this whole subject had been pretty well investigated and settled for most conditions, to the extent that it has gotten into the textbooks. We thought it was generally understood that the initial pressure and temperature at which steam should be generated in industrial plants is determined largely by the uses of the steam and power in processes. Seldom is process steam required at more than 300 or 400 F and more than 150 psi conditions. To supply that, it is usually satisfactory to employ extraction and back pressure turbine plants for 650 psi 750 F in.tial steam conditions or lower.

It should be noted that many of the boiler plants installed for the war industries have been relatively low-pressure boiler plants, generating steam at 150 or 200 psi and relatively moderate temperatures, drawing the required electric power from the available power pools, to save the critical time and materials needed to construct steam turbines and boilers. Under peace time conditions if the economic and engineering analysis in these cases had shown that extraction or back pressure turbines should be installed, the fact would remain that the steam extracted or exhausted to process from these turbines would still have been at relatively low pressure and temperature.

One very good typical article that treats all important phases of this problem is "Modernization of Paper Mill Power Plants," by Warrington, in the July, 1939 issue of POWER PLANT ENGINEERING, and there are many others not only in POWER PLANT ENGINEERING but in the other technical magazines.

Black Liquor for Gas Turbines?—Another interesting condition encountered by the above consulting engineer was in certain paper mills where because of changes in the steam and power balance, it was necessary to purchase considerable power in addition to what they could economically generate by steam and by all available water power.

In some of these plants the consulting engineer thought it might be worth while to investigate the use of the gas turbine for supplying this incremental power without additional steam. Furthermore, he thought, it might be well to investigate the use of black liquor from pulp-making processes as a fuel for the gas turbine. It would require a rather careful study to determine whether or not the economic advantages of black liquor recover boilers would be greater than the economic advantages of burning the liquor as gas turbine fuel—if it could be burned for this purpose. We do not know that any such study has ever been made. It might be worth while, at least for the paper industry.

Three for the Book—It isn't enough that engineers have got to stew, along with the rest of the citizenry, about Bretton Woods and Dumbarton Oaks and post-war world conditions. They also need to take more interest than they do at present in their individual and professional status, their place and function in society today and tomorrow. But as if that were not enough, the engineer also has problems of his own field to solve, problems that are strictly technical, that have nothing to do with post-war world conditions or the larger sociological questions of our time.

Whether or not the CIO acquires jurisdiction over the collective bargaining of professional and technical men, whether or not the San Francisco meeting reaches decisions that will lead to a long period of peace in the world, somebody's got to get some real information about how to stop the high maintenance and operating difficulties caused by magnetic iron oxide, Fe_3O_4, in modern high-pressure equipment.

Chemists have known for years how this oxide is formed in boilers but as long as steam temperatures and pressures were low, it did not cause much trouble. But as temperatures and pressures have risen in steam generating equipment, and especially as they get up into the 900 psi range, this oxide creates real problems in cleaning and sometimes affects the operation of valves and other equipment. Designers of equipment can help, of course, to eliminate crevices and ledges on which the oxide may accumulate. But this is merely a makeshift remedy. The real remedy is to remove the magnetic iron oxide or prevent its formation. The central station engineer has had this problem for some time. As high-pressure and temperature equipment becomes more widely used in industrial plants, industrial power engineers are beginning to encounter it also.

The cost of hydrogen determinations in boiler water and steam is high and it must be balanced against the cost of shut-downs or repairs chargeable to this factor. Just how much study of the subject is now going on is difficult to determine. We know of at least two utility organizations and one industrial power plant that are carrying on such studies. If they yield definite information on what to do, it will come in very handy as the high-temperature development continues after the war.

Another problem distracting the attention of engineers from world affairs is boiler feed pump corrosion. We are receiving a continuously increasing amount of comment on this and many inquiries about how to prevent it, of which Question No. 291 in the March issue is typical. Without doubt the pump manufacturers in cooperation with the pump users, will find the solution. At present, the only thing that can be said is that this pump corrosion seems to be a factor of both turbulence and chemical action. And there seems to be little difficulty with it if stainless steel can be used—but that's expensive and still doesn't remove the cause of the trouble.

Some people argue that the world must get itself so organized that engineers can devote their time to technical problems of this kind without having to stop every few years and help their sons fight another war. Other people argue that just the opposite is true: that under the stress of war, the solutions of technical problems are reached sooner because of the stimulus to save our own necks. Whichever view you hold, you must admit that things are "snafu" these days for the engineer.

GRAND COULEE Sets the Pace

By the U. S. Bureau of Reclamation, Department of the Interior

The first detailed technical article on the hydro-electric power generating equipment at Grand Coulee, which paces the Northwest Interconnected Power Systems . . . Plant designed for ultimate capacity of 1,974,000 kw . . . Present capacity is 818,000 kw . . . Eight Francis type main units now installed; six of 150,000 hp capacity each; two units of 103,000 hp each, designed originally for Shasta Dam . . . Ingenious method of installing counterclockwise Shasta units for clockwise rotation at Coulee . . . Details of turbines, generators, control, auxiliaries . . . Generation at 13.8 kv, transmission at 115 and 230 kv . . . Here are no "arty" pictures, no Sunday supplement feature writing, but instead the details that mean something to engineers, straight from men who know.

RECENT COMPLETION of the installation of all generating equipment in Grand Coulee Power Plant which was authorized by the War Production Board, makes it now the "Pace Maker" of the Northwest Interconnected Power Systems. Of the 18 generating units and 3 station-service units provided for in plans for the project, two 12,500-kva station-service units, six 108,000-kw main units, and two 75,000-kw temporary units have been installed, bringing the present total installed capacity to 818,000 kw. Development of this capacity at this time is considerably ahead of the original schedule of development of generating capacity, which will ultimately reach 1,974,000 kw.

The Grand Coulee Power Plant is located at the Grand Coulee Dam, on the Columbia River, about 90 miles west of Spokane, Washington, and is the uppermost of 10 dams planned for ultimate development on the Columbia River. Bonneville Dam, 146 miles above the mouth of the Columbia River, has already been completed by the U. S. Army Engineers.

The Columbia Basin Project, the object of which is the irrigation of 1,029,000 acres of fertile land in the Big Bend, an abandoned glacial-age valley of the Columbia River, is made economically practical through the development of electric energy for pumping water to the valley, and through income from the sale of power in the rapidly growing markets of the great Northwest. It is estimated that the income from the sale

Fig. 1. View of generator room at Grand Coulee, left power house, showing six of the eight units now installed there. (All photos by Bureau of Reclamation, except as noted)

Fig. 2. General view of Grand Coulee Dam and power houses. (Photo by Robert Yarnall Richie, courtesy Allis-Chalmers Mfg. Co.)

of this power will repay approximately one-half of the entire cost of the project in the 40 yr period provided for retiring irrigation costs under the Reclamation Law, thereby greatly reducing the cost otherwise chargeable to the farmers. It was the existence of the major engineering feature of the project, the Grand Coulee Dam, that made possible the unusually rapid increase of generating capacity urgently needed in the Northwest for the war industries. The Grand Coulee plant was centrally located for pooling in the Northwest Interconnected Systems, which, for the war, cover an area which reaches into Washington, Oregon, Idaho, Montana, and Utah.

The Grand Coulee Dam

The gravity-type dam contains more concrete than any other single structure in the world. It has a 1,650-ft central spillway section, Fig. 2, flanked by a power house and abutment section on each side, 1200 to 1500 ft long. At the left or west end of the dam is an adjoining wing dam, behind which will be located the pumps for irrigation. At the foot of the spillway, below the level of the river channel, is a "bucket" or artificial plunge-pool of a horizontal semi-cylindrical shape, 90 ft wide and 30 ft deep, with its downstream edge submerged 30 to 75 ft, depending upon the river's flow. Normal elevation of the reservoir is maintained and the downstream flow of the river is controlled by eleven drum gates, each 135 ft long and 28 ft high. The drum gates, which are hollow floats, hinged at the upstream edge, are raised and lowered by the reservoir level as water is admitted to or released from the recesses beneath the gates. Eventually the drum gates will be adjusted automatically by floats near the gates, or manually by remote control from the power house, to maintain a uniform reservoir level, or to prevent abrupt changes in river elevation. Drainage of the reservoir can be accomplished with the sixty 8½-ft conduits which run through the dam.

Water is delivered from the reservoir, through the dam, to the turbines, through penstocks 18 ft in diameter, sloping from intakes at elevation 1041 to the connections to the turbine scroll cases, with centerlines at elevation 938. The penstocks are steel tubes, embedded and grouted in the concrete of the dam, their shells ranging in thickness from ¾ to 1½ in. The steel penstocks were electrically welded, and are designed to withstand the stresses due to the full hydrostatic head plus water-hammer, without exceeding two-thirds the yield strength of the material. This is approximately twice the stress that would have been used had the penstocks not been embedded. The intake openings to the penstocks are controlled by coaster gates, 15 ft wide by 29 ft 7¾ in. high, of heavy structural and plate steel construction. The gates are hydraulically raised and lowered, and have hydraulically operated water seals to

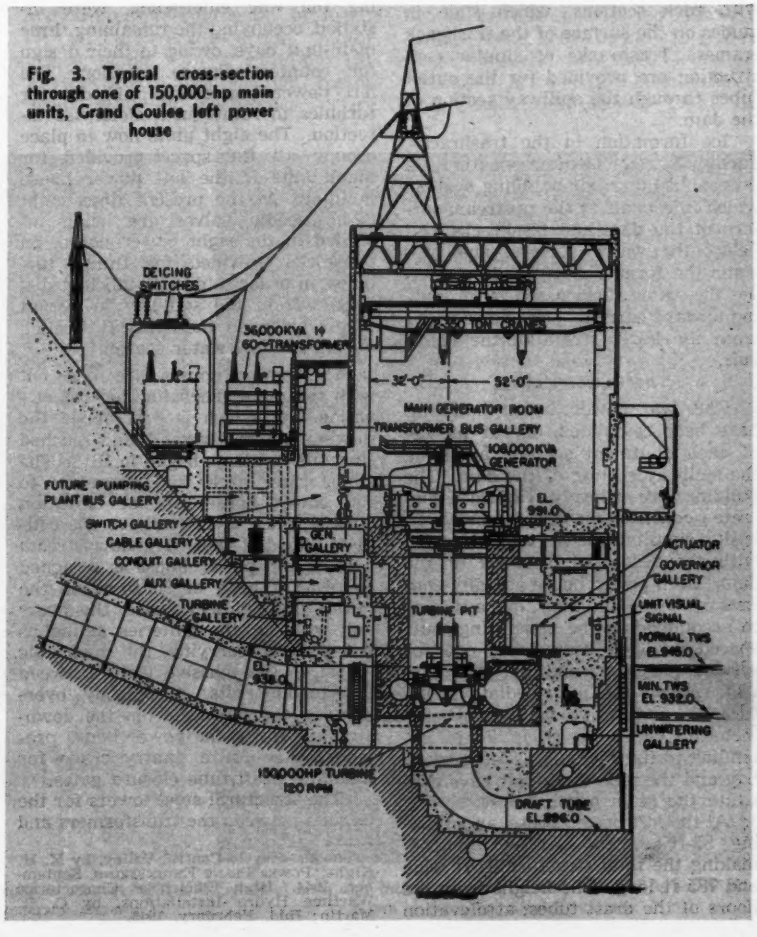


Fig. 3. Typical cross-section through one of 150,000-hp main units, Grand Coulee left power house

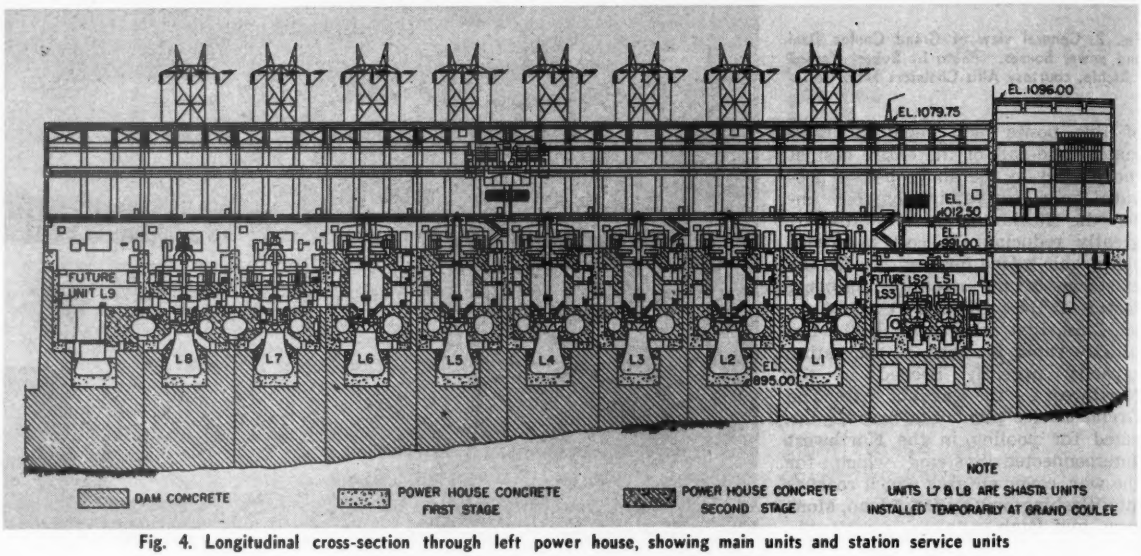


Fig. 4. Longitudinal cross-section through left power house, showing main units and station service units

fit to the seats in the face of the dam, around the penstock opening.

A separate trashrack structure is provided for each of the 18 main penstock openings and the 3 station-service penstock openings. They are semicylinderical in shape, with their longitudinal axes vertical on the face of the dam, and are of reinforced concrete construction, suitably fitted with rack sections, which slide in guides on the surface of the trashrack frames. Trashracks of similar construction are provided for the outlet tubes through the spillway section of the dam.

Ice formation in the trashracks, during extreme winter weather, is prevented by an air-bubbling system, which injects air at the upstream surface of the dam and trashrack, well below the water surface, and prevents the formation of ice by agitating the water surface and by producing upward currents of warmer water from the lower strata of the reservoir.

The Power Houses

The two power house buildings have been completed, one at the toe of each abutment section, adjoining the spillway section of the dam. The buildings are of heavy reinforced concrete construction, on foundations built simultaneously and integral with the respective sections of the dam. Each power house actually consists of eleven buildings, or bays, nine to accommodate the generating units spaced on 65-ft centerlines, one for service purposes, and one for control. Above the intermediate structure, the bays are separated by one-inch cork-filled expansion joints, extending to the roof. The 85-ft service bay and the nine main-unit bays consitute the main power house.

At the left power house, an adjoining 85-ft control bay is provided, making the total structure 84 ft wide and 785 ft long. The height from the floors of the draft tubes, at elevation 896, to the parapet of the control bay is 200 ft. A similar control building will be provided, eventually, on the right side of the river, also. Two of the three station-service units provided for in the left power house have been installed, and six main generating units, in six of the nine main-unit bays. Two units, borrowed from the Shasta Power Plant* during the war emergency, were installed, occupying the remaining three main-unit bays, owing to their design for counterclockwise rotation. The left power house was laid out for turbines to rotate in a clockwise direction. The eight units now in place occupy all the space provided for main units in the left power house building. At the present time, eight 84-in. needle valves are being installed in the right power house, on penstocks provided for future turbines, in order to divert sufficient discharge from the spillway to permit repair work on the spillway bucket, during the low water season.

The power houses are laid out with the main-generator floor at elevation 991, which is 6 ft above the maximum flood water stage reached since observations began in 1913. The transformer deck, and entrances to the power house, are at elevation 1012.5, which is 12 ft above the estimated flood of 1894. The downstream wall of the power house is designed to resist a head of 90 ft above the lowest open gallery space, the floors and walls of the galleries acting as box-girders, carrying the hydraulic thrust to the massive walls between the turbine pits. A balcony overhanging the tailrace from the downstream wall of the power house provides space for a gantry crane for handling draft-tube closure gates.

The structural steel towers for the circuits between the transformers and the switchyard are mounted on the roof. The main transformer decks, at elevation 1012.5, are located between the downstream face of the dam and the upstream wall of the power house. A concrete structure along the power house wall houses the connections between the transformers and generators, and the transformer low-voltage delta buses, disconnecting switches, etc. In the left power house, a gallery is provided, at elevation 991, directly adjoining the main-generator terminals, and extending to the foundation for a gallery which will run diagonally up the face of the dam, along the abutment, to the pumping plant. It will house electrical connections between main-unit generators and pumping-plant motors.

Main Unit Turbines

The main-unit turbines in the left power house were specially designed because of their size and because of the large variations in both forebay and tailwater elevations. These turbines are of the Francis reaction type, Fig. 3, 120 rpm, rated 150,000 hp at 330 ft, the weighted average head, and 90,000 hp at 263 ft, the minimum head. The turbine-efficiency test has shown, however, that these units will develop a maximum of 164,500 hp, and will maintain turbine efficiency above 90 per cent from approximately 106,000 to 159,000 hp, all at 330-ft head, while maximum turbine efficiency of 91.2 per cent occurs at 135,000 hp.

The main-unit scroll cases consist of 14 steel castings, bolted together, and embedded in reinforced concrete. A test ring, which fitted inside of the speed ring, was used to seal the scroll case, which was then tested at 225 psi (50 per cent above normal pressure), before concrete was placed over the scroll case. The pressure was then dropped to the normal operating pressure of 145 psi, and the concrete placed. This method of erection, developed by the Bureau of Reclamation, eliminates stresses and

*Shasta—Key to Central Valley, by M. H. Kight; POWER PLANT ENGINEERING, September, 1944. High Efficiencies Characterize Wartime Hydro Installations, by C. R. Martin; Ibid, February, 1945.

consequent cracking of the concrete around the scroll case under normal operating conditions. The speed rings, which were cast integral with the scroll cases, are stiffened by 14 fixed guide vanes.

Each of the 9-in. shafts of the 24 wicket gates is carried in three pressure-grease-lubricated bronze-bushed guide bearings, one in the curb plate below the speed ring, and two in the crown plate, one above and one below a stuffing box. A shear pin in the gate-operating lever protects each gate from injury in case its movement is obstructed. Eccentric pins provide means of adjusting and compensating for wear. Two 34-in.-diam, double-acting hydraulic cylinders or servo-motors, under control of the governor, operate the wicket gates.

Runner Details

Each turbine runner is a single steel casting, 197 in. in diam, with an entrance height of 34⅜ in., and 19 vanes. The runners were designed to vent atmospherically, at small gate openings, at the tip, and at 4 points on the cone just below the discharge edge of the vanes. This venting is adequate for normal operation; but, when the tailwater surface is more than 10 ft above the centerline of the distributor, hydraulic disturbances occur in the draft tube. They are, at present, controlled by forcing air at 5 to 10 psi through the central runner vent. This is necessary only during the high water season. The runner vanes were reduced in thickness, beginning 12 to 15 in. from their trailing edges, which were thinned down from about 1 3/16 in. to ¾ in. That was necessary to eliminate the formation of "Karman Vortex Streets" (eddy sheets) at the trailing edges of the vanes, and the consequent high-frequency vibration of the whole turbine. Cavitation of the runners and draft tubes is negligible.

The shafts are 44-in. in diam. They have 6-in. axial holes for inspection, and these also serve to admit air to the runner tip for venting, as mentioned above. An 18-ft section of the shaft, attached to the runner, Fig. 6, and a 24-ft intermediate section, Fig. 5, were furnished by the turbine builder, the 31-ft upper section was made by the generator builder. The sections are joined by means of 75-in. flanges, holes in the flanges being reamed and fitted with ground bolts, 2.5 to 5 ten-thousandths inch oversize. Bolts are shrunk by cooling in dry ice, before being put in place. They can be shrunk for removal by passing liquid air through axial holes provided in the bolts for that purpose. The sections of the shafts which pass through the packing boxes are equipped with replaceable stainless steel wearing sleeves.

The turbine guide bearings are 45-in. in diam. and 41½ in. long. They are of the split-shell type, and are oil-pressure lubricated, by means of an alternating-current motor-driven pump with a stand-by, battery-operated, direct-current motor-driven pump for emergency service, which cuts in automatically if the lubricating oil pressure drops below a safe value. Lubricating oil is water-cooled, in a heat exchanger, outside of the 100-gal oil sump.

If removal of the major parts of the turbine becomes necessary, that can be accomplished by removing the generator bracket, rotor, and shafts. That allows the overhead cranes access to the turbine parts, which can all be lifted out through the generator stator.

The draft tube receives water from the runner at a velocity of approximately 30 fps, under maximum discharge. The water passes through a concrete elbow, which is split into three passages by two intermediate vertical piers in the horizontal section of the draft tube. The design of the draft tube is such as to reduce the maximum velocity of the water to about 8 fps at the discharge to the tailbay.

Shasta Turbines

In the Pacific Northwest, shipbuilding, aluminum plants, and other war industries had been growing at such a rate that the need for additional power became quite critical about the time that war was declared by the United States, on December 8, 1941. The second group of 3 main units was being manufactured, but it would require nearly two years to bring them into operation. There were, however, two 75,000-kva units already fabricated for installation in the Shasta Dam Power Plant. As

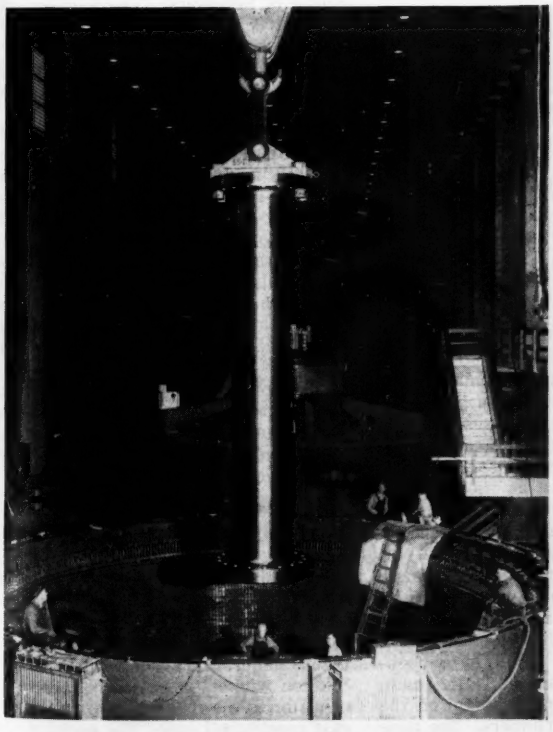


Fig. 5. Erection of a main unit; intermediate shaft to connect turbine and generator being lowered through generator stator

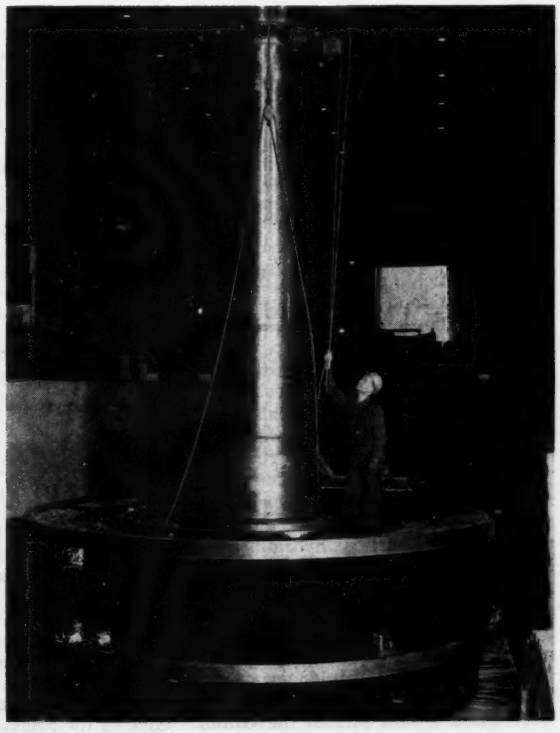


Fig. 6. A main unit turbine runner and shaft ready to be set in place in one of the Grand Coulee turbines

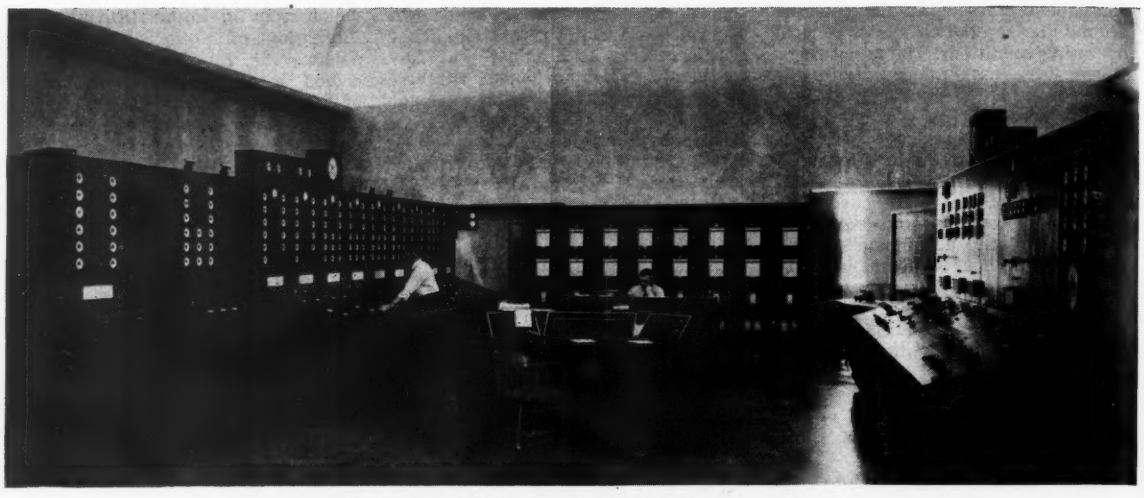


Fig. 7. The main control room in Grand Coulee power plant

work had previously been held back on the construction of Shasta Dam, because of the diversion of labor and material to more immediate war uses, the Shasta plant would not be ready for its first two units for a considerable length of time.

With these two units ready for installation but with no plant ready to receive them, and the reverse situation being true at Grand Coulee Dam, it was only natural that the engineers of the Bureau of Reclamation should try to fit these two units into the available space in the Grand Coulee Power Plant. Expense or difficulties involved could not be permitted to hold up the transfer, for if the power output of these machines could shorten the war by days or even hours, the country would be fully repaid in the saving of lives and the saving of the enormous daily cost of sustaining war. From this standpoint there was no question that the first two Shasta units should be installed in the Grand Coulee Power Plant.

Rotation of Units

There was, however, one major problem which proved very troublesome. The Grand Coulee units in the left power house all rotate clockwise when viewed from the top consequently the relation of penstock to the draft tube in each turbine pit would accommodate only this type of unit. The Shasta units were designed for counterclockwise rotation. There was not room to provide a 90-degree elbow between the penstock and the scroll case; furthermore, it would not be practical hydraulically. However, by cutting through the 8-foot concrete wall between turbine pits, and installing a 57-degree elbow, a penstock could serve a unit rotating counterclockwise, in the adjacent turbine pit. This would, in effect, waste one turbine pit, but as there were three vacant pits in the Grand Coulee Power Plant this would cause no hardship until the plant was expanded, and expansion would not occur until after the completion of the war, when the Shasta units could be removed for installation at Shasta Dam.

The Shasta turbines* are of the Francis reaction type, 138.5 rpm, rated 103,000 hp at 330-ft head. However, the specifications called for the units to be able to operate under a variable head of 238 ft to 475 ft. The turbine-efficiency test on one of these units indicated its ability to deliver a maximum of 115,300 hp at 330 ft head, and to maintain turbine efficiency over 90 per cent from 71,000 to 109,000 hp. The maximum turbine efficiency of 92.1 per cent occurs at approximately 95,000 hp for this head. On account of hydraulic disturbances in the draft tube, due to the change in draft-tube section required to fit the smaller turbine, the Shasta units are not operated normally above about 114,000 hp.

The scroll cases for these two units are of the plate steel type, with riveted and welded joints, and cast steel speed rings. A test ring was provided with these units, and the same procedure that was used in testing and concreting around the scroll cases of the main Grand Coulee units was followed. The scroll cases are equipped with 24 fixed guide vanes, which line up directly with the 24 wicket gates, when the gates are wide open. The wicket-gate lubrication, adjustment, and protection facilities are essentially the same as those of the main units. The gates are operated by two 28-in.-diam. servo-motors, which are controlled by the governor.

Each Shasta-unit runner is a single steel casting, 184 in. in diam, with an entrance height of 31 in. and 15 vanes. The runner is designed to vent atmospherically at small gate openings, much the same as the main units; however, there is no tip on the cone of the Shasta runners. The cone is stopped at a diameter of about 30 in. and the venting air goes to whichever point is under the lower pressure. There was no cavitation of these runners after 14 months of operation.

The shafts of the Shasta units are 38 in. in diam, and have 7½ in. axial holes the full length of the shafts, for inspection purposes. Each shaft is in two sections, one 19 ft 6 in. long, connected to the turbine runner, and the other 32 ft long, integral with the generator rotor. The 64¾-in. diam flanges of the shafts are bolted together by 18, 5-in. diam, ground bolts, in holes that are reamed 2.5 to 5 ten-thousandths in. under size. The bolts have 1¼-in. diam axial holes for application of liquid air, if removal is necessary. The sections of the shafts which pass through the packing boxes are equipped with replaceable stainless steel wearing sleeves, which consist of two halves held together by shrink links.

The turbine guide-bearings are of the split-shell type, 38¼ in. in diam and 29½ in. long. These bearings are pressure-lubricated by means of alternating-current motor-driven oil pumps for normal service, and battery-operated, direct-current motor-driven pumps, which start automatically when the lubricating pressure drops below a given point. The lubricating oil is water-cooled, in a heat exchange outside of the oil sump.

The removal of any of the major turbine parts is accomplished through the generator stator, as in the main units, overhead cranes handling the larger pieces.

Station-Service Turbines

The station-service turbines, shown in Fig. 4, are each rated at 14,000 hp at a head of 330 ft and a speed of 400 r p m. They are of the Francis type. The runners are single steel castings, 63 in. in diam, with an entrance height of 11½ in. and 15 vanes. Sixteen wicket gates control the flow of water to the turbine from two-piece cast steel scroll cases, the speed rings of which are stiffened by 8 fixed guide vanes.

The turbine shafts are 14 in. in diam, and are provided with 3 in. diameter axial inspection holes. A replaceable stainless steel wearing sleeve covers the shaft at the packing box area. Turbine guide-bearings are 14⅛ in. in diam and 20 in. long, oil-pressure-lubricated from alternating-current motor-driven oil pumps, with stand-by service provided by battery-operated direct-current, motor-driven oil pumps. As in the case of the larger units, all major turbine parts may be removed through the generator stator by the use of an overhead crane.

The station-service draft tubes are of the steel concentric-cone type, discharging into a larger concrete exit section. No cavitation has occurred in the draft tube, and a very little has shown up on the runner, after approximately three years of operation.

Governors

The large turbines are equipped with governors of the "actuator" type, that is, the speed-responsive element (fly-balls), the valves, the control mechanism, and the oil pressure pumps are in a unit, separate from the hydraulic cylinders (the servo-motors) which operate the turbine gates. There are three connections between the turbine and its actuator: (a) a three-phase circuit connecting a permanent-magnet generator on the main shaft to a small synchronous motor which in turn drives the speed-responsive element in the actuator, (b) the "restoring" or "compensating" connection, which returns the pilot valve to its balanced position after a gate movement has brought the turbine to normal speed as a consequence of a change of load, and (c) the oil piping through which power to move the turbine gates is transmitted from the actuator to the servo-motors.

Within the actuator housing are the synchronous-motor-driven speed responsive element, valves, restoring mechanism, and two 40 hp motor-driven oil pumps of sufficient capacity to operate the turbine gates through full range three times per minute. An external 300-psi pressure tank contains sufficient oil and compressed air to open or close the gates five times, independently of the oil pumps.

The 400,000 ft-lb, double-acting servo-motors are of a capacity to move the wicket gates through their full strokes in 4 seconds, with oil pressure at its minimum of 250 psi and an operating head of 355 ft. Gate operating time is adjustable from 4 to 12 seconds.

Brakes on the rotor, controlled manually or automatically from the governor cabinet, cannot be applied automatically until the turbine gates are closed and the speed has fallen to 30 rpm. The automatic brake action may be continuous or intermittent, as desired, with adjustable time intervals.

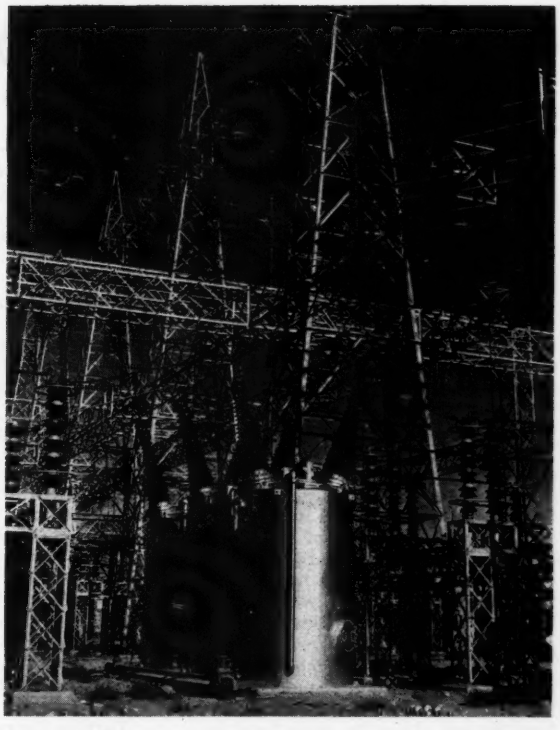
The 350,000 ft-lb double-acting servo-motors control the wicket gate position, and provide a gate-closing time of 4 seconds. Both opening and closing time are adjustable from 4 to 12 seconds. A 300 psi external pressure tank provides reserve capacity for the two 40-horsepower oil pressure pumps.

The rotor brakes are controlled manually or automatically from the governor control board; they cannot, however, be applied automatically until the speed has dropped below 45 rpm. Automatic braking can be continuous or intermittent, with adjustable time intervals.

The station-service governors differ from the main-unit governors in that each is a self-contained unit. The actuators, 42,000 ft-lb servo-motors, 200 psi pressure tanks, and 7½-hp oil pumps are all contained in the governor cabinets. Connections to the wicket gates are made through an 8-in. vertical torsion shaft, operating connecting rods to the gate-shifting rings. Gate operating time is adjus-

(Continued on page 91)

Fig. 9. View of left switchyard, showing 230-kv oil circuit breaker in foreground



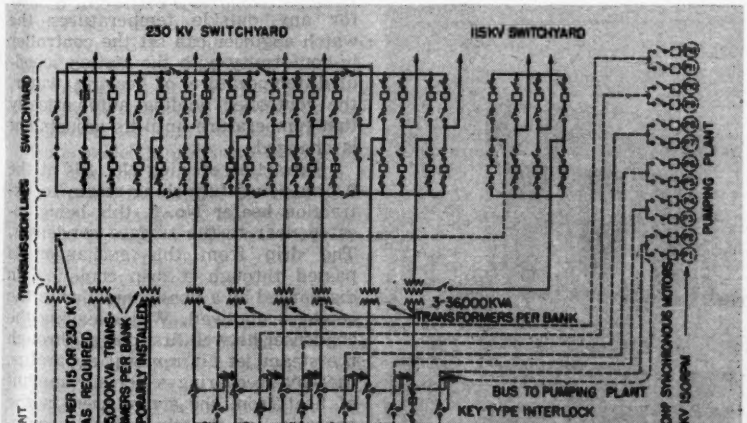


Fig. 8. Single-line electrical diagram of connections, Grand Coulee

Additional Capacity for Boone Station

Iowa Electric Light and Power Co. plant at Boone being enlarged by addition of 10,000 kw turbine generator unit—Four points of steam extraction complying with tentative ASME standard—Steam at 650 psi, 800 F—Reverse current valves protect extraction openings—Generator windings protected by differential relays—Commercial operation to begin in November, 1945—Heat balance on unit given for winter conditions

By JOHN M. DRABELLE Mechanical and Electrical Engineer, Iowa Electric Light & Power Co.

IN THE LATE SUMMER of 1944 the Iowa Electric Light and Power Co. management decided to install in conjunction with the high pressure boiler now installed at Boone a new turbo-generator to replace the unit which had been previously ordered in 1941 and which due to the demands of the war had been transferred to other service by the War Production Board. Accordingly, an application was filed with the Office of War Utilities, War Production Board at Washington, and upon proper hearing the application for this unit was granted by the War Production Board on October 12, 1944.

During the summer months engineering details were completed and worked out. The basic design and thinking are along the same lines except as to size and number of extraction openings as the new unit of the Central States Electric Co. now being installed at Iowa Falls.

Essentially, the turbine is a 10,000 kw, tentative ASME standard unit with four points of steam extraction. Throttle pressure of 650 psi and a throttle temperature, maximum of 800 F. The capability of the unit at improved power factor is 12,540 kw when heating its own water, and in addition furnishing from one extraction opening the steam to the heat exchanger of the central hot water heating system at Boone.

On December 22, 1944, the Boone project was uprated by the W.P.B. from an AA-3 to AA-2X, thus considerably expediting the entire project.

The principal items of equipment are obviously the turbine, the condenser, the extraction feedwater heaters and certain miscellaneous pumps. This is given in detail in the accompanying summary.

Turbine Extraction Features

For heating the feedwater and supplying heat for the central hot water heating system, four standard ASME openings are provided in the turbine shell for steam extraction, supplying steam to the several heat exchangers involved in the feedwater heating cycle.

Extraction opening No. 1 supplies steam at 226 psia to extraction heater No. 1. This heater is of the high pressure type and equipped with a desuperheating zone, thus giving a negative terminal difference on the feedwater leaving that heater. The final temperature of the water going to the boiler is 394 F. at full load.

Extraction opening No. 2 is at the 120 psia point and furnishes steam to extraction heater No. 2 which is of the high pressure type. Both high pressure extraction heaters are of the floating internal cover type, with cupro-nickel tubing on account of the pressures and temperatures involved.

Extraction opening No. 3 furnishes steam at 41 psia to the deaerating feedwater heater which in the cycle is designated as heater No. 3. The amount of steam admitted to this heater is controlled by Foxboro Stabilog type controller holding the temperature in the feedwater heater at 220 F. or 17.3 psia, thus giving the boiler feed pump the benefit of relatively cool water to handle.

Steam from opening No. 3 is also supplied to heat exchanger No. 4 which is the exchanger connecting to the central hot water heating system. The admission of steam to this heater is controlled by an adjustable Foxboro Stabilog controller so that for any outside temperatures the watch engineer can set the controller in conformity with the station scheduled temperature of leaving water, the controller holding automatically that temperature until its adjustment is changed.

Extraction opening No. 4 is at the 9 psia point, furnishing steam to extraction heater No. 5, this being located near to the surface condenser. The drip from this exchanger is passed through a drip cooler, then discharged by a float controller to the condenser hotwell. Water leaving the condenser hotwell first passes through the steam jet air removal apparatus, thereby recovering a certain amount of heat from the steam used in the operation of the air removal equipment. The second stage drip from the air removal equipment goes to the sewer as a protection against ammonia in the system. The water then

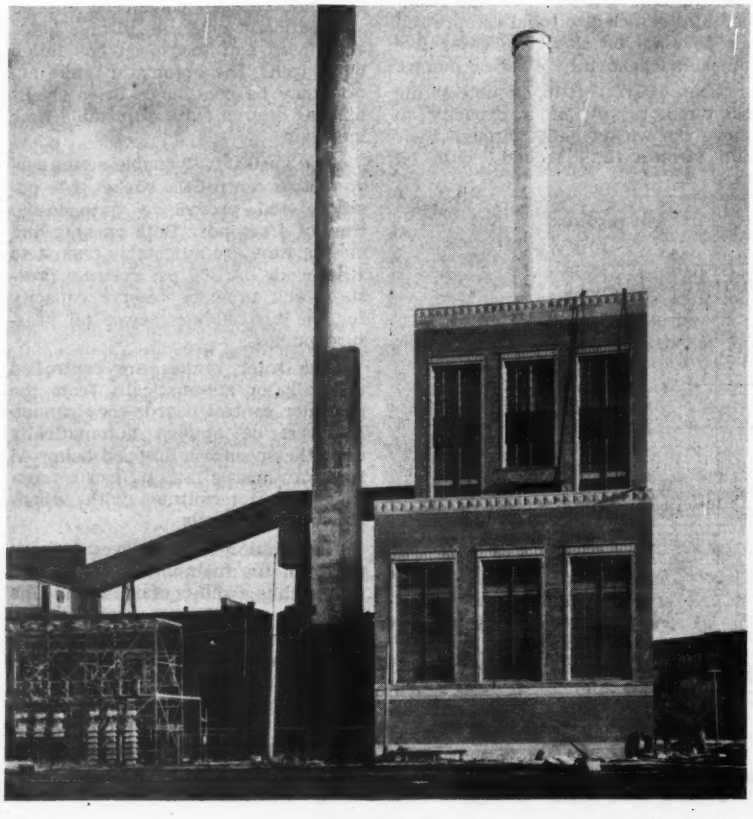
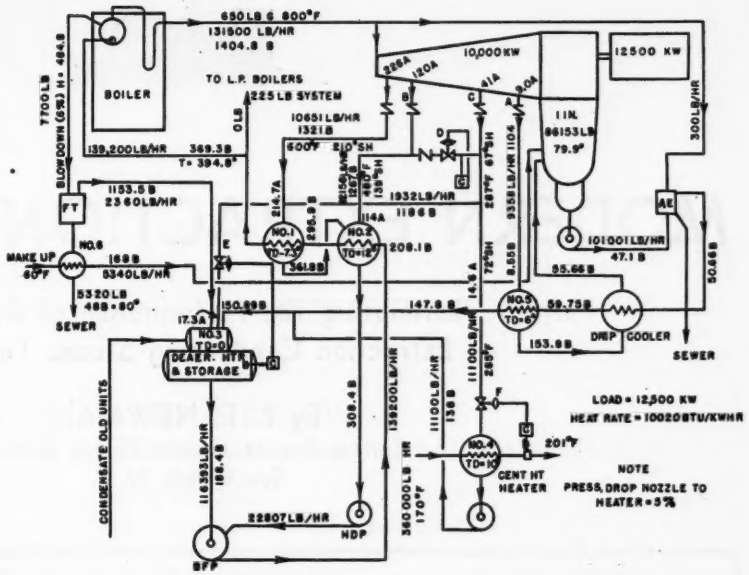


Fig. 1. Boone Station looking east toward new turbine room; boiler house and stack in background

Fig. 2. Heat balance diagram for new 10,000 kw unit at Boone showing winter conditions



flows through the drip cooler of No. 5 heater, thence through No. 5 heater to the deaerating heater No. 3.

At this point the water is picked up by the boiler feed pump, and forced under full boiler pressures through extraction heaters No. 2 and No. 1. The drip from extraction heater No. 1 cascades to extraction heater No. 2; is then picked up by a drainer pump which delivers the accumulated drip of heaters 1 and 2 to the second stage of the boiler feed pumps. In arranging the cycle in this manner, only one drainer pump is used. The drip from central heater No. 4 is pumped by a hotwell pump to deaerating heater No. 3.

Each extraction opening and its associated feedwater heater is protected by an Atwood and Morrill reverse current valve of the oil pressure open-spring close type, the oil operating cylinders of the valves being connected to the turbine governor oil system of the machine, so that in event of the operation of the turbine overspeed device the reverse current valves are all mechanically closed.

Electrical Hookup and Protective Provisions

Electrically, the turbine unit feeds its output to a machine transformer rated 10,000/12,500 kva which is connected through the 34.5 kv generator oil switch to the 34.5 kv bus of the Boone substation. For operation of the various auxiliaries associated with the unit and the new boiler, these are fed from two sources.

During the starting up period, the auxiliary power is supplied through a 2300 v to 480 v transformer bank rated 1500 kva; after the unit is synchronized to the 34.5 kv bus, the auxiliary power is automatically transferred to a 1500 kva transformer, rated 13.8 kv to 480 v, for the various boiler and turbine auxiliaries.

Differential relay protection is provided for the generator windings; the neutral point of the generator winding is connected to earth through a current limiting reactor. There is also provided a protective relay which will trip the generator oil switch in the event of a failure of the 13.8 kv auxiliary power transformer or any of the associated 13.8 kv cable and wiring between the generator terminals and the machine transformer.

Tripping is also provided in connection with the turbine governor gear so that in event of the operation of the relays protecting the machine against grounding or abnormal earth current or failure of the other electrical wiring associated with it the generator oil switch and the throttle valve of the turbine are tripped. In event of the operation of the overspeed device on the turbine due to steam conditions or other mechanical abnormal conditions, the generator oil switch is tripped. In each case the tripping of the generator oil switch also trips the field switch of the machine.

The excitation is provided from a shaft coupled main and pilot exciter operating in conjunction with suitable voltage regulator of the automatic type.

Control System

The entire control system is concentrated at two panels: (1) the conventional generator electrical panel, and (2) turbine control panel having the various gages, thermometers and other instruments associated with the turbine mounted on it, together with the control switches for controlling the various turbine auxiliaries such as circulating pumps, hotwell pumps, drainer pumps and other similar equipment.

After the watch engineer opens the turbine throttle valve, he does not need to step out of his tracks to place the unit in complete operation, mechanically and electrically. The entire effort in the design of the Boone turbine has been to reduce the burden on the operating force to the absolute minimum and to make it as near self-starting as it is possible with a steam turbo unit.

The pipe work will be done by the Midwest Piping and Supply Co. of St. Louis, Mo. All connections are extremely short. The feedwater heaters are of the vertical type so as to permit of easy maintenance when and if tube renewals become necessary. All valves associated with the extraction heaters are located on the operating floor.

It is expected that the unit will be in regular commercial operation on or before November 15, 1945. E. A. Holloway will be the Resident Engineer in charge of construction.

Major Items of Equipment

Turbine—Allis-Chalmers Mfg. Co., rated 10,000 kw, 12,500 kva, 0.8 pf, 13.2 kv, 3600 rpm with main and pilot exciter. Steam condition 650 psig, 800 F. total temperature. Exhaust 1 in. to 2.5 in. Hg. absolute. Four extraction points for feedwater heating. Griscom-Russell air cooler. Vacuum trip and rupture diaphragm. Turbine capability 12,540 kw at 1.0 pf at 2.5 in. Hg. and heating its feedwater.

Condenser—Allis-Chalmers Mfg. Co., 11,000 sq ft. Admiralty arsenical tubes, ⅞ in. dia. No. 18 B.W.G., 18 ft long, 2,670 tubes. Two pass top inlet with vertically divided water box.

Circulating Pumps—2—7,000 gpm, 695 rpm. Motor driven by 100 hp, 440 v, 3 phase induction motor.

Condensate Removal Pumps—2—250 gpm 1750 rpm, 2 stage, total head 150 ft. Driven by 20 hp, three phrase, 440 v induction motor.

Air Removal Equipment—Allis-Chalmers Mfg. Co. 2 two stage twin element steam jet air ejectors.

Feedwater Heaters—The Griscom-Russell Co., closed type, floating inside covers.

Heater Designat'n	1	2	5	Drain Cooler
Temp. Water:				
Leaving	392.8	325.4	179.9	91.7
Entering	325.4	239.2	91.7	82.7
Steam Press., psia	214.7	114.0	8.55	....
Steam Temp., F.	600	480	....	....
No. sq. ft.	1000	452	517	90
Tube Material	Cu-Ni.	Cu-Ni.	Adm.	Adm.

Miscellaneous Pumps—

Service	No. of Units	Make	GPM	Head
No. 2 Heater Drain	1	(*)	53	365
Central Heat Drain	1	(*)	50	160
House Service	2	(*)	400	231
Surge Tank	2	(*)	100	135
Treated Water	2	(*)	30	125
Hotwell LP Unit 3.	1	(*)	60	160
Hotwell LP Unit 4.	1	(*)	160	235
Hotwell LP Unit 5.	1	(*)	55	160

*Ingersoll-Rand.

Traveling Crane—30 ton capacity. The Whiting Corp.

Pressure Gages — Dial type thermometer and temperature controllers. The Foxboro Co.

Valves, Piping and Fabrication — Midwest Piping & Supply Co.

Turbine and Auxiliary Foundation—Lippert Bros., General Contractors, Boone, Iowa.

Electrical Equipment

Machine Transformer—10,000/12,500 kva, 13.2 kv to 34.5 kv with four 2½% taps, 3 phase. General Electric Co.

Auxiliary Power Transformer—1500 kva, 13.2 kv to 480 v, 3 phase. General Electric Co.

Generator Oil Switch—34.5 kv. General Electric Co.

Turbine Control Panel — Load center unit, contractors, relays, wire and cable.—General Electric Co.

MODERN EXTRACTION TURBINES*

Part IV. Estimating the Performance of Double-Automatic, Extraction Condensing Steam Turbines

By L. E. NEWMAN
Turbine Division, General Electric Company
Schenectady, N. Y.

THIS may be the first time in technical literature that a method has been published to estimate performance of the double automatic extraction steam turbine. Perhaps some other author has had the temerity to tackle this problem before, but we doubt it.

Lou Newman sent us a few performance charts from actual turbines, on which he had marked in red lines the estimate of performance that results from the short cut method on these pages. We were astonished at the errors—not how big they were, but how small. In many cases the red lines of this estimate, and the black lines of the actual turbine fell one upon the other.

We believe this is a fundamental contribution to the literature on extraction turbines. Check it against any actual performance chart you have—we think you'll share our surprise.

DOUBLE-AUTOMATIC extraction turbines are heat-balance units. They can maintain constant pressures in two process-steam lines, supply these lines with all of their requirements for steam, carry base electrical load only, or take the peaks, and, in some cases, maintain frequency constant enough for electric clocks. With their three sections: high-pressure, intermediate, and low-pressure, each designed for different conditions of flow and pressure, it might be thought that there would be no easy way of estimating their performance. This is not the case.

How to obtain a complete performance chart for a condensing double-automatic extraction steam turbine has been reduced to a method that involves only a few steps of simple arithmetic, and the plotting of four points. It is true that a spider web of lines result, but none of these lines requires more than the drawing of a straight line between two points or drawing a line parallel to another line. The result is a complex-appearing, but easily read performance chart.

In the February and March issues of POWER PLANT ENGINEERING short-cut methods were given for estimating the performance of single-automatic extraction condensing and non-condensing type turbines. In this article a companion method is given for estimating performance of condensing double-automatic extraction steam turbines. This method is limited to 50- or 60-cycle units rated 1000 kw to 7500 kw inclusive. It is doubtful if there are any applications that can be justified for double-automatic extraction turbines rated less than 1000 kw. Generally these useful machines will be found in the range of ratings from 3000 kw to 7500 kw inclusive. Occasionally, an application can be justified for more than 7500 kw, but such applications are exceptional.

The performance chart for this type of turbine is the familiar throttle flow versus output chart to which has been added a family of lines for each of the automatic extractions. The essence of such a chart is shown as the last part of Chart 1, and a completed chart is shown in Chart 5. Note that performance charts such as these make it possible to read the throttle flow for any condition of load and extraction flow. It is no more difficult to prepare and use this chart than similar diagrams for single extraction turbines.

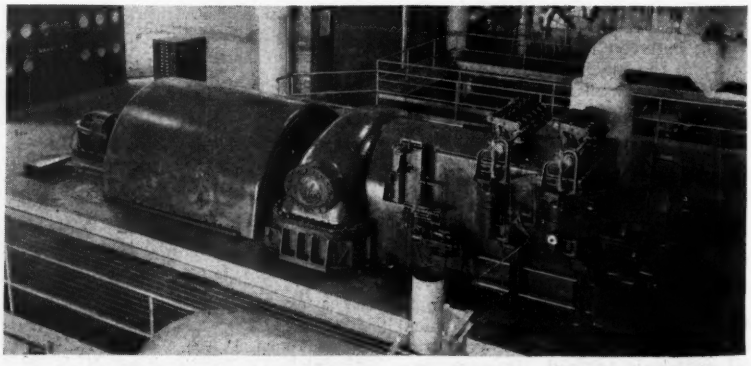


Fig. 1. 7500-kw Double Automatic Extraction Steam Turbine, installed in an industrial power plant

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EXAMPLE PROBLEM

RATING: 4000 kw .8 pf 5000 kva 60 cycle

STEAM CONDITIONS:

Throttle	400 psi g	700 F
High-pressure extraction	150 psi g	
Low-pressure extraction	20 psi g	
Exhaust	2 in. Hg Abs.	

MAXIMUM REQUIRED EXTRACTION FLOWS:

High pressure	100,000 lb per hr
Low pressure	60,000 lb per hr

(The solution of this problem is given in italics on the STEP BY STEP METHOD and Chart 5.)

STEP BY STEP METHOD

for determining performance of double-automatic extraction condensing steam turbines driving 50 or 60 cycle generators.

CALCULATIONS

$TSR_1 =$ *7.60* lb per kwh = Theoretical Steam Rate, from throttle to exhaust (Table 1).
$TSR_2 =$ *33.6* lb per kwh = Theoretical Steam Rate, from throttle to high-pres. extract'n (Table 1).
$TSR_3 =$ *14.7* lb per kwh = Theoretical Steam Rate, from throttle to low-pres. extract'n (Table 1).
Eff. = *0.675* Efficiency (Table 2).

A = Full-load nonextraction throttle flow $= \dfrac{TSR_1 \times \text{Rated Output}}{\text{Efficiency}}$

$= \dfrac{7.60 \times 4000}{0.675} =$ *45,000* lb per hr

B = Half-load nonextraction throttle flow = A × half-load flow factor (from Table 3) $=$ *45,000* $\times$ *0.595* $=$ *26,800* lb per hr

$\dfrac{TSR_1}{TSR_2} = \dfrac{7.60}{33.6} =$ *0.226*

E_{HP} = High-pressure extraction factor = *0.82* (Chart 2).

$\dfrac{TSR_1}{TSR_3} = \dfrac{7.60}{14.7} =$ *0.517*

E_{LP} = Low-pressure extraction factor = *0.53* (Chart 2).
F_{HP} = Max. required high-pressure extraction flow = *100,000* lb per hr
F_{LP} = Max. required low-pressure extraction flow = *60,000* lb per hr

C = Full-load throttle flow at max. required low-pressure extraction flow, but ZERO high-pressure extraction flow
$= A + (E_{LP} \times F_{LP}) =$ *45,000* $+$ *(0.53* $\times$ *60,000)* $=$ *76,800* lb per hr

D = Full-load throttle flow at max. required high-pressure extraction flow, but ZERO low-pressure extraction flow
$= A + (E_{HP} \times F_{HP}) =$ *45,000* $+$ *(0.82* $\times$ *100,000)* $=$ *127,000* lb per hr

S_{HP} = Min. flow to intermediate section (Read from Chart 3 at H.P. extraction pressure) = *5500* lb per hr

S_{LP} = Min. flow to exhaust (Read from Chart 3 at L.P. extraction pressure) = *3000* lb per hr

M = Max. permissible throttle flow (Chart 4) = *250,000* lb per hr

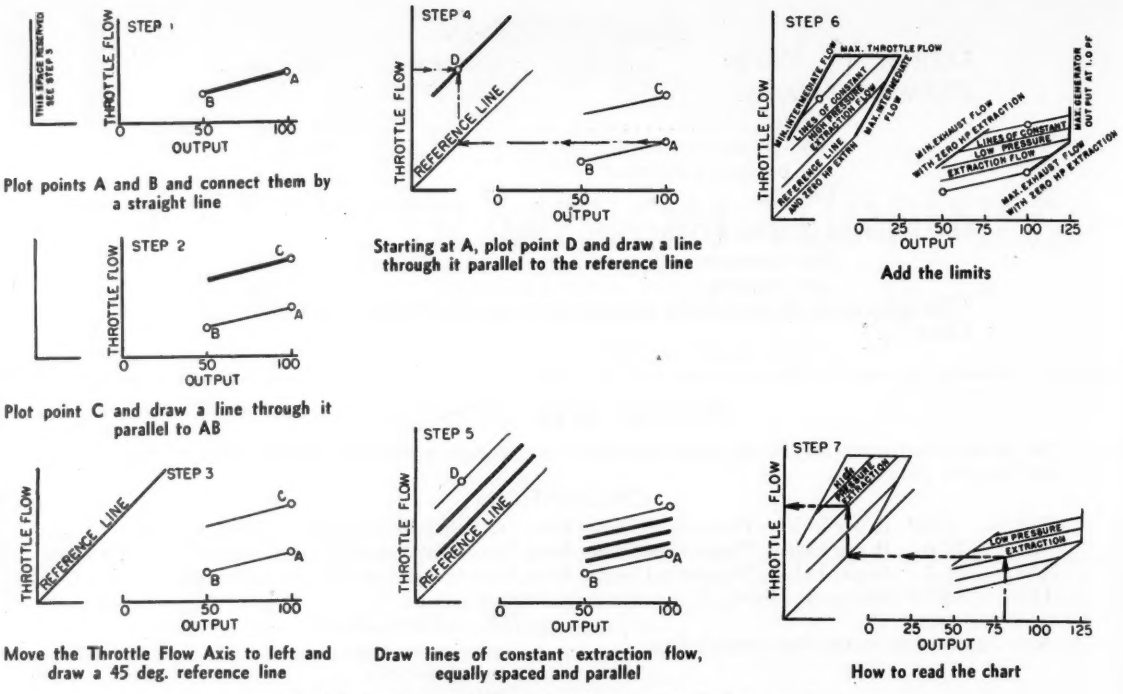
HOW TO DRAW PERFORMANCE CHART

Plot points A, B, C, and D, and draw the straight lines indicated by Chart 1. *(The example is plotted on Chart 5.)*

Prepare a table of limits:

Section of Turbine	Limiting Flow, in lb per hr			
		Maximum		Minimum
High pressure	(Note 1) =	*135,000*	none =	*0*
Intermediate pressure	C =	*76,800*	S_{HP} =	*5500*
Low pressure	A =	*45,000*	S_{LP} =	*3000*

Note 1. Take the *least* of the following for max. high-pressure section flow:
M, or 3 × A, or D + ($E_{LP} \times F_{LP}$)
M = 250,000
3 × A = 3 × 45,000 = 135,000 ← Use
D + ($E_{LP} \times F_{LP}$) = 127,000 + (0.53 × 60,000) = 158,800



Plot points A and B and connect them by a straight line

Plot point C and draw a line through it parallel to AB

Move the Throttle Flow Axis to left and draw a 45 deg. reference line

Starting at A, plot point D and draw a line through it parallel to the reference line

Draw lines of constant extraction flow, equally spaced and parallel

Add the limits

How to read the chart

Chart 1. Step-by-step Method of Constructing the Performance Chart

Table 1. Condensed Table of Theoretical Steam Rates*

Main Pressure, psi, g	150	200	250	300	400	600	850
Initial Temp., F	450	500	550	600	700	750	825
Initial Superheat, F	(84)	(112)	(144)	(178)	(252)	(261)	(298)
EXHAUST PRESSURE	THEORETICAL STEAM RATES, IN LB./KW.HR.						
1 in. Hg. Abs	9.09	8.54	8.10	7.71	7.06	6.63	6.19
2 in. Hg. Abs	9.98	9.32	8.79	8.34	7.60	7.09	6.58
3 in. Hg. Abs	10.62	9.87	9.28	8.78	7.96	7.40	6.85
EXTRACTION PRESSURE							
0 lb./sq. in. G	18.2	16.1	14.6	13.4	11.7	10.4	9.31
5 lb./sq. in. G	20.3	17.7	15.9	14.5	12.5	11.1	9.83
10 lb./sq. in. G	22.4	19.3	17.2	15.6	13.3	11.6	10.3
20 lb./sq. in. G	26.7	22.3	19.5	17.5	14.7	12.7	11.1
30 lb./sq. in. G	31.3	25.4	21.9	19.4	16.0	13.6	11.8
40 lb./sq. in G	36.4	28.7	24.3	21.2	17.2	14.5	12.5
50 lb./sq. in. G	42.4	32.3	26.8	23.1	18.5	15.4	13.1
100 lb./sq. in. G	...	58.1	42.5	34.1	25.1	19.4	15.9
150 lb./sq. in. G	...	...	...	51.1	33.6	23.8	18.6
200 lb./sq. in. G	...	...	...	...	45.8	29.0	21.5
250 lb./sq. in. G	...	...	...	...	...	35.3	24.8

*From "Theoretical Steam Rate Tables," by J. H. Keenan and F. G. Keyes, published in 1938 by A.S.M.E.

Table 2. Full-load Non-extraction Efficiencies for Condensing Double-automatic Extraction Steam Turbines

RATINGS, IN KW AT 0.8 PF	MAIN PRESSURE, IN PSI, G						
	150	200	250	300	400	600	850
	EFFICIENCY						
500 625 750	Double-automatic extraction can rarely be justified for units rated less than 1000 kw.						
1000	.625	.620	.615	.610	.600	.580	...
1250	.640	.635	.630	.625	.615	.595	...
1500	.650	.645	.640	.635	.625	.610	...
2000	.665	.660	.655	.650	.640	.625	...
2500	.675	.670	.665	.660	.655	.640	...
3000	.685	.680	.675	.670	.665	.650	...
3500	.690	.685	.680	.675	.670	.660	...
4000	.695	.690	.685	.685	.675	.665	...
5000	.705	.700	.695	.690	.685	.675	.665
6000	.710	.705	.700	.700	.690	.680	.675
7500	.715	.710	.710	.705	.700	.690	.685

There are three distinct phases in estimating the performance chart of a double-automatic extraction turbine:

1. *Estimate the steam flows* for four basic points. This takes only the few minutes needed to go through the simple arithmetic shown on the STEP BY STEP METHOD.

2. *Plot the performance* chart exclusive of limits. This is the simple procedure shown in the first five steps of Chart 1.

3. *Add the limits* to the chart. These limits are a matter of convenience that need not be added to the chart. In place of them the table of limits prepared during the STEP BY STEP METHOD may be used.

Each of these phases will be discussed in some detail while determining the performance chart for an actual turbine. Note that the example problem includes the minimum data needed to prepare a performance

Table 3. Half-load Flow-Factor

RATING IN KW AT 0.8 PF	FACTOR
500 625 750	....
1000 1250 1500	0.605
2000 2500 3000	0.600
3500 4000 5000	0.595
6000 7500	0.590

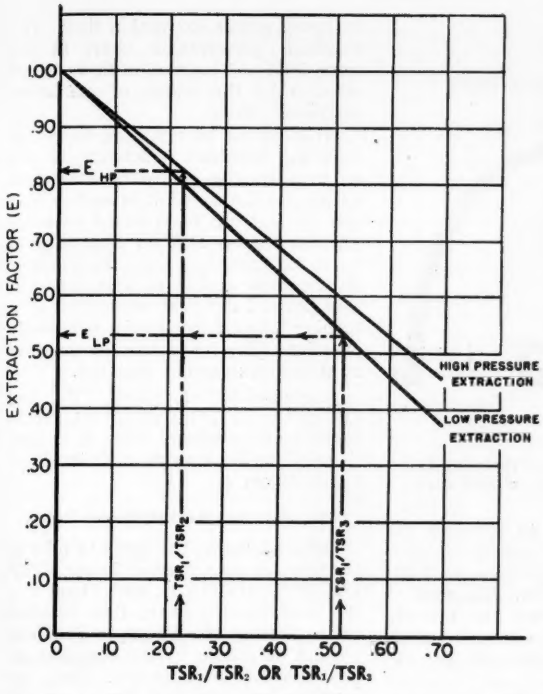


Chart 2. Extraction Factor vs Ratio of Theoretical Steam Rates

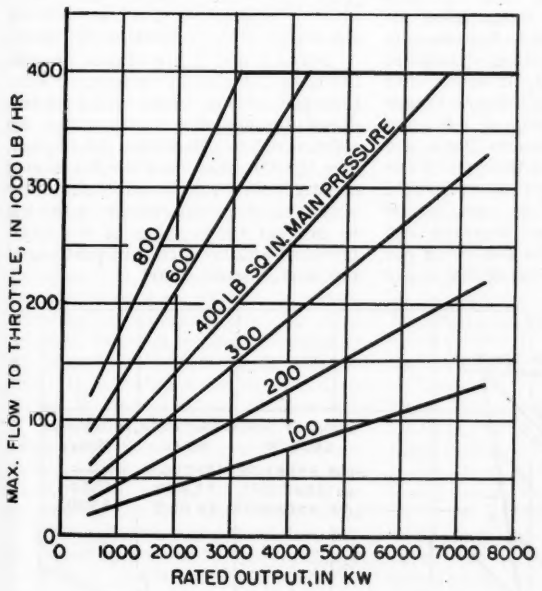


Chart 4. Maximum Throttle Flow vs Rated Output. Estimates should be limited to those coming within the maximum throttle flows shown on this chart

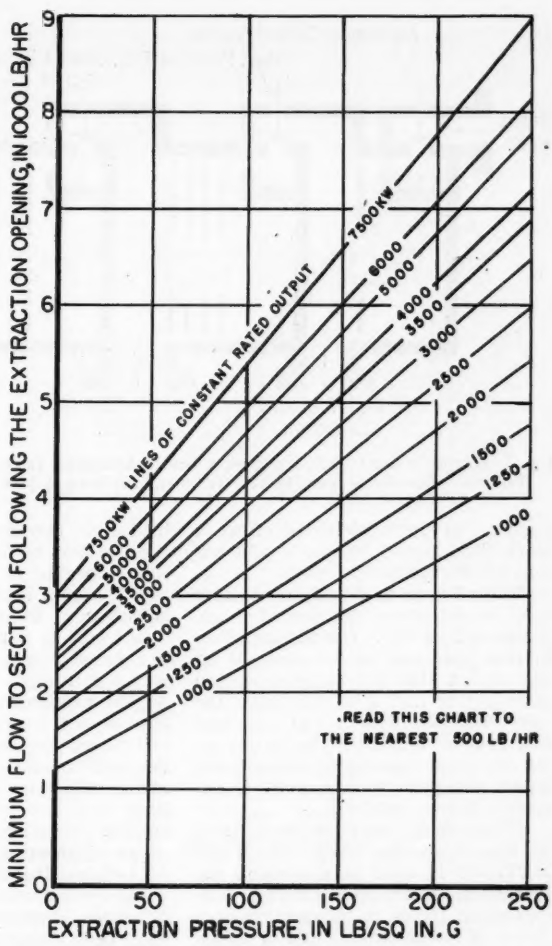


Chart 3. Minimum Flow to Section Following the High Pressure or Low Pressure Automatic Extraction Opening vs Extraction Pressure

chart. These minimum conditions are: the rated output, the steam conditions, and the desired maximum extraction flows.

The Step By Step Method (See Tables)

It is usually easier to complete the arithmetic of the STEP BY STEP METHOD before starting to plot the performance chart than to mix the two operations. The first step, therefore, is to take a piece of scratch paper and write down the three theoretical steam rates.

These theoretical steam rates can be read from Table 1 if the required steam conditions are available in the table, but the table is greatly condensed and is largely included to show the form of such a table. Often times it will be necessary to obtain the information from the excellent Theoretical Steam Rate Tables of Keenan and Keyes (published by American Society of Mechanical Engineers) or from a Mollier chart.[1] In any case, determine these theoretical steam rates with care—they influence greatly the result.

In the example problem, the theoretical steam rates were read from Table 1 and the values are shown in italics on the STEP BY STEP METHOD.

The full-load efficiency is read from Table 2 at the proper rating and main pressure. For the example problem, it is 0.675 at 4000 kw rating, 400 lb main pressure.

Sufficient data have now been determined to calculate the first point, designated as "A". This first point, the full-load non-extraction flow, is the basic point used as a pivot for determining the other points. A slip made in determining this point will reflect itself throughout all remaining points.

The fact that this basic point "A", and the remaining three points, are so easily determined is the greatest disadvantage of this method. Most engineering calculations are of such a complex nature that "rule of thumb" and other short-cut checks can be made to catch a gross error. Not so in this method. All of the short-cuts have been taken—any check calculation would be long and cumbersome—so, even though this method takes less than ten minutes of simple arithmetic, take the time to recheck each

[1] Thermodynamic Properties of Steam, by J. H. Keenan and F. G. Keyes, John Wiley & Sons, Inc., N. Y., 1936.

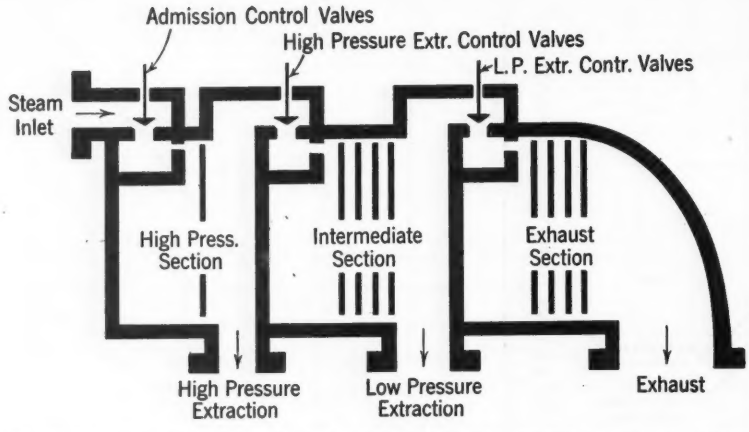


Fig. 2. Schematic Cross Section through a Double-Automatic, Extraction Condensing Steam Turbine. (Reproduced from "Modern Turbines," Published by John Wiley & Sons, Inc.)

figure. The slight additional effort is more than repaid by the confidence that can be put in the result.

Table 3 gives half-load flow factors used to determine the second point, designated as "B". The factors given in this table are on the basis of an assumption that all turbines of the same rating and type will have the same half-load flow to full-load flow relationship. Obviously, this is not so, but the error introduced is negligible unless the performance chart is extended below half-load.

The ratio of theoretical steam rates as shown on the STEP BY STEP METHOD is used to determine the extraction factors from Chart 2. The extraction factor is the portion of a pound of steam which must be added to the throttle flow for each pound of steam extracted. Thus, in the case of the Example Problem, at constant load it is necessary to increase the throttle flow by 82 lb per hr for each 100 lb per hr of high-pressure (150 psi G) steam extracted. Likewise, it is necessary to increase the throttle flow by 53 lb per hr for each 100 lb per hr of low-pressure (20 psi G) steam extracted.

The maximum required extraction flow is not a critical figure in this estimating method. Preparation of the performance chart, however, is made easier by choosing maximum flows that are readily divisible into smaller flows. In preliminary stages of an engineering study of this type of turbine, the maximum flows are usually not known. In the case of the Example Problem no error would have been introduced by using larger or smaller maximum required extraction flows than the 100,000 lb per hr high-pressure and the 60,000 lb per hr low-pressure extraction flow. The resultant performance chart at the same load and extraction flows is not affected by the choice of maximum extraction flows.

It is not to be supposed from this that the turbine's efficiency is not affected by the choice of maximum extraction flows—what is said is that this method has been based on average maximums and no correction is made for variations from the average. In the first article of this series it was pointed out that no section of a turbine should be made needlessly oversize. This holds true in the case of double extraction turbines.

Calculations of points "C" and "D" on the STEP BY STEP METHOD present no problems. Also, it is easy to read the limiting flows from Chart 3 and Chart 4.

Plotting the Performance Chart

Chart 1 shows the steps to take in plotting the data derived in the STEP BY STEP METHOD, and Chart 5 is the performance chart that resulted from plotting the Example Problem. Do not be misled by the complex appearance of these charts. They are nothing but straight lines, equally spaced, and parallel to each other. More time may be spent in choosing the scales than in drawing the chart.

Steps 1 and 2 are simple enough, but Step 3 looks mysterious. It isn't, however, and no error will be introduced by choosing a slope for the reference line other than 45 degrees. The throttle flow axis can be located at any point, too, but for simplicity it is usually moved enough to the left to prevent overlapping of the high-pressure and low-pressure portions of the performance chart.

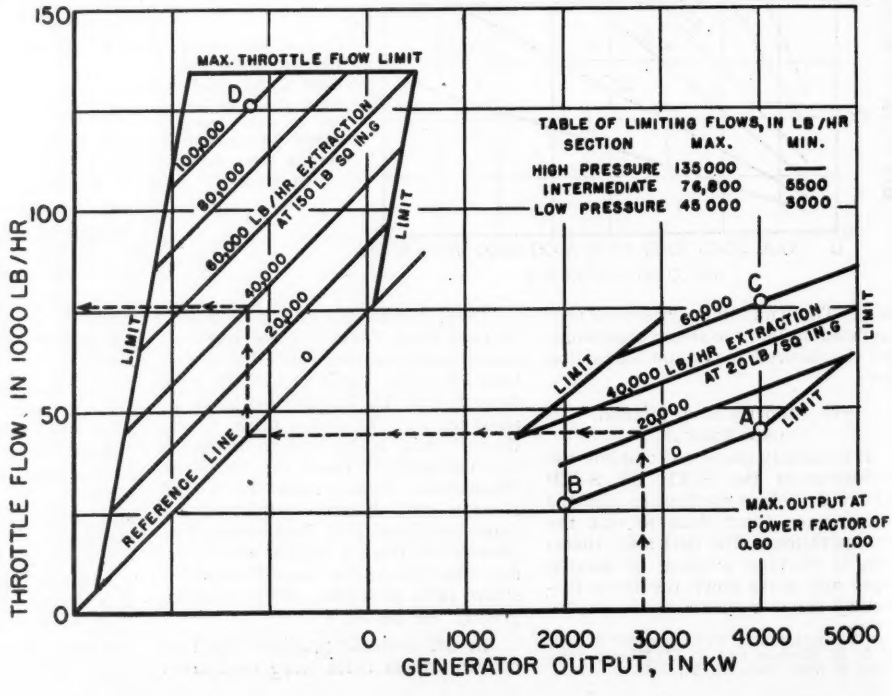


Chart 5. Performance Chart for 4000-kw Example Unit. Initial Steam Condition: 400 psi, g, 700 F. High Pressure Extraction: 150 psi, g. Low Pressure Extraction: 20 psi, g. Exhaust Pressure: 2 in Hg Abs

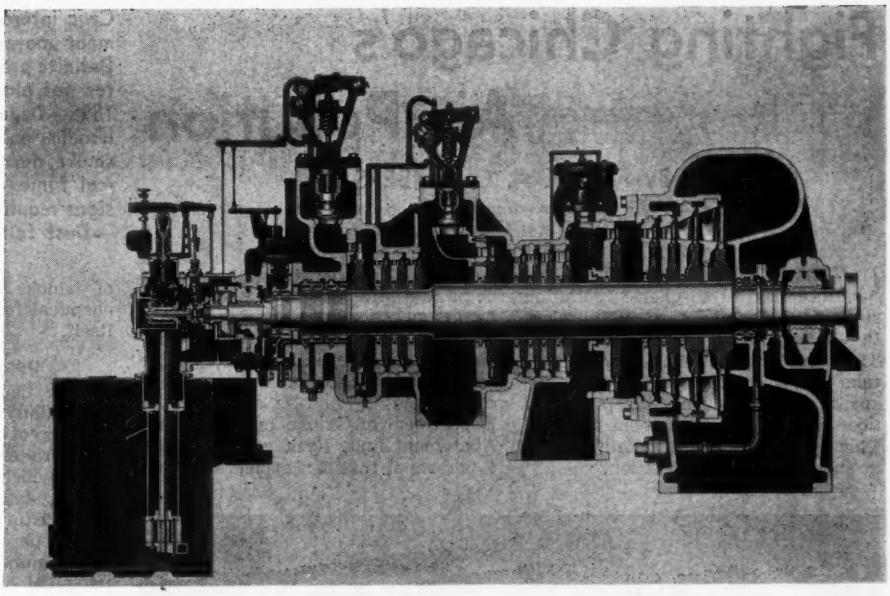


Fig. 3. Cross-section of a Double-Automatic Extraction Condensing Steam Turbine

Step 4 consists simply in plotting throttle-flow "D" at a point directly above the reference line corresponding to full-load with no low-pressure extraction, or, in other words, point "A". Then a line is drawn through point "D", parallel to the reference line.

Except for limits, the chart is completed in Step 5 by drawing lines of constant extraction flow equally spaced and parallel between zero extraction and the maximum. Chart 5, for example, shows high-pressure constant extraction flow lines of 20,000, 40,000, 60,000 and 80,000 lb per hr drawn between 0 and 100,000 lb per hr extraction. These lines are simply for convenience in reading the chart. Their position may be fixed by using dividers, or by a couple of triangles and simple geometry, or by calculation. If calculation is preferred, it should be remembered that each line of constant extraction flow is separated from its neighbor by a distance equal to the extraction flow difference times the extraction factor. Thus, in the case of Chart 5, each of the lines of high pressure extraction flow are separated by a distance equal to 20,000 x 0.82, or 16,400 lb per hr and the low pressure lines by a distance equal to 20,000 x 0.53, or 10,600 lb per hr.

Adding the Limits to the Chart

Rather than add all of the limits to the performance chart, it will usually be found time saving to add only a few of the limits and rely on the table of limits for those not shown on the chart.[2] The table of limits derived, as shown on the STEP BY STEP METHOD, is used by reading any desired point from the extraction chart and then checking to see that the flow through the turbine's high-pressure, intermediate, and low-pressure sections are within the limits given in the table. This is done by using the following simple formulae:

High-Pressure section flow = throttle flow

Intermediate section flow = throttle flow minus high-pressure extraction flow

Low-Pressure section flow = throttle flow minus high-pressure extraction flow minus low-pressure extraction flow

To show, by example, how this works, follow the dashed line on Chart 5 which shows that:

At an output of 2800 kw

with low-pressure extraction of 20,000 lb per hr

and high-pressure extraction of 40,000 lb per hr

the throttle flow is 76,000 lb per hr

Thus,

High-pressure section flow = 76,000 lb per hr

Intermediate section flow = 76,000 — 40,000 = 36,000 lb per hr

Low-pressure section flow = 76,000 — 40,000 — 20,000 = 16,000 lb per hr

In each case, these flows are between the maximum and minimum section flow limits shown by the table.

The limits given in the table can be plotted on the chart, but the resultant maze of lines may be more confusing than helpful. Usually it suffices to draw on the chart the maximum throttle flow limit, and the maximum generator output limit.

Conclusion

The design of a double-automatic extraction steam turbine is influenced by the (1) initial pressure, (2) initial temperature, (3) high-pressure extraction pressure, (4) low-pressure extraction pressure, (5) exhaust pressure, (6) maximum and (7) minimum expected high pressure extraction demand, (8) maximum and (9) minimum low pressure extraction demand, and (10) the rating. These ten variables must all be taken into account when making the final design of this type of turbine. By taking them into account, the turbine is fitted to the power plant's needs.

This short-cut method is a composite of many double-automatic extraction steam turbine performance charts. It gives approximations within five per cent in the usual case, but does not show the gains that may be possible from taking into account the special conditions of operation that exist in most industries.

Manufacturers' turbine specialists should be consulted early in studies involving these useful turbines—they are experienced in taking into account the ten variables that affect the design of each machine.

Note: This is the concluding installment of Mr. Newman's series on Modern Extraction Turbines. Parts 1, 2 and 3 appeared in the Jan., Feb. and Mar., 1945, issues, respectively.

[2] The limits for double extraction turbines are discussed in more detail in Modern Turbines, by Newman, Keller, Lyons, and Wales. John Wiley & Sons, Inc., N. Y., 1944.

Coal Movements

Bituminous coal forwarded to New England dupring the present fuel year from April 1, 1944, to March 10, 1945, totaled approximately 20,965,535 tons, representing a substantial decrease under shipments in either of the two preceding years and reflecting reduced production, Solid Fuels Administrator Harold L. Ickes announced today.

In the corresponding period of the 1943-44 fuel year, soft coal forwarded to the area exceeded that total by about 1,292,017 tons. Forwardings on the 1942-43 fuel year were approximately 1,616,730 tons larger, he said.

During the week ending March 10, some 531,159 tons of bituminous coal were moved to New England. This total was 30,629 tons below that of the preceding week, the decrease being due in part to a shortage of railroad cars at the mines.

Fighting Chicago's Air Pollution

By FRANK A. CHAMBERS
Smoke Inspector
City of Chicago

Civic interests started smoke abatement movement in early eighties—Definite progress began when inspector was placed under civil service in 1895—Department now equipped to handle pollution problems due to smoke, dust, metallurgical and chemical fumes—Furnace and boiler designs require approval of department—Dust fall is continuously recorded

CHICAGO'S first attempt to reduce its atmospheric pollution started as far back as 1881, when the first smoke ordinance was passed. The year 1891 saw the civic groups take a very active interest in the smoke problem. This was primarily due to a desire to present a clean Chicago for the World's Fair visitors at the Columbian Exposition.

In 1895, the Deputy Smoke Inspector was placed under Civil Service, which has enabled his office to perform its duties more effectively than would have been possible under a different set-up. Under the direction of the Deputy Smoke Inspector in Charge there are ten junior mechanical engineers, in addition to the other twenty-five employees of the Department. The experiences of these engineers are varied, some of them being former practical operating engineers, others being technically trained mechanical and chemical engineers. The former experience of these men is complementary and as a result, the Department of Smoke Inspection and Abatement finds itself equipped with a personnel that can attack any kind of smoke, dust, metallurgical or chemical fume problem that presents itself.

Fig. 1. Technicians making spectroscopic and microscopic examination of dust from Chicago's atmosphere

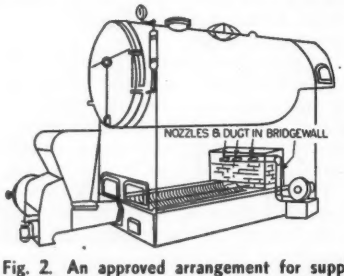


Fig. 2. An approved arrangement for supply over-fire air in underfeed stoker fired furnace to produce turbulence and increase furnace temperature

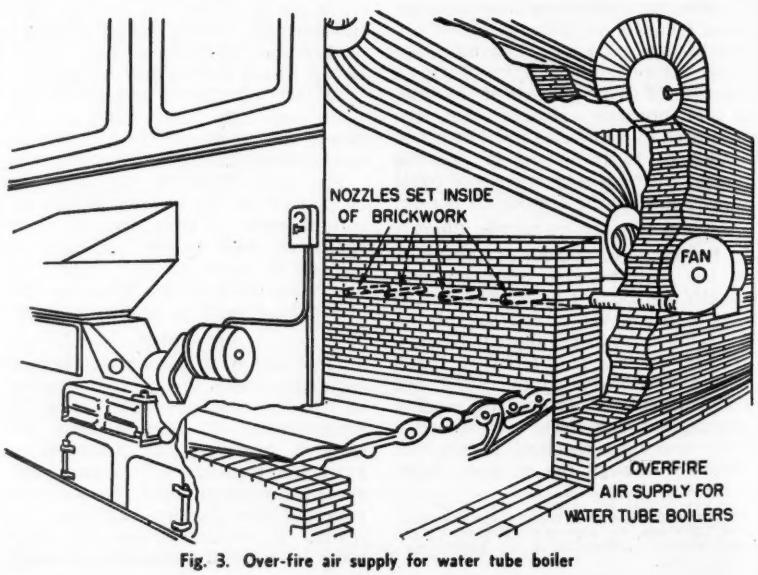


Fig. 3. Over-fire air supply for water tube boiler

Department Operation

The department is in receipt of many daily complaints from Chicago citizens of nuisances from premises that are emitting smoke or noxious gases which may be injuring people's health, damaging property or which may disturb their physical comfort and repose. These complaints are given immediate attention by a department engineer who visits the source of nuisance and advises the responsible party in charge what to do to abate the nuisance.

The department also obtains evidence of violations of the dense smoke section of the Smoke Ordinance by observation of chimneys of buildings, railroad locomotives and boats. These reports are made as a part of the routine observation work of the department observers and not necessarily as a result of complaints being received. After noting the violation, an attempt is made to secure the cooperation of the responsible party in charge to attain an immediate abatement of the nuisance. Expert advice is offered as to firing methods, changes in furnace equipment or type of fuel used, depending upon the cause of the smoke.

After the preliminary warnings and recommendations for the elimination of sources of complaint and smoke violations have been given, a

close follow-up is made of the plant to find out if the department's warning is being heeded. If future violations occur, final hearings are held in an attempt by the Deputy Smoke Inspector to find out if any steps are being taken to stop smoke. If no cooperation is secured, the offender is taken to court as a last resort.

Long Range Plan

In addition to these active means of trying to secure immediate abatement of isolated smoke cases, the department has a long range plan of eventually completely freeing Chicago of smoke. This is being accomplished by the insistence that all new or reconstructed furnaces installed in Chicago, be designed to operate smokelessly. Before any such installation can be made, plans must be submitted to the department's plan examiner, who checks the plans to see if the layout has been made in accordance with present day scientific design and can thereby operate smokelessly. Only such designs as he approves will be permitted to be installed.

A close check-up is made by a department engineer to see that the installation is made according to the approved plans. This inspection is then followed by observation on the stack serving the plant when it is fired up, to see that it can operate smokelessly.

As a result of this activity it is hoped that eventually all old and poorly designed equipment will be supplanted by modern plants that will permit Chicago to be known as the "cleanest city in the United States," a title of which we could be greatly proud, because Chicago's great industrial activity and close proximity to the soft coal mines of the middle west, make her a natural sufferer from smoke.

Educational Program

In addition to the above mentioned activities, the department carries out an educational program. Numerous articles on the abatement of smoke have been written for technical publications read by engineers and janitors. Firing classes are conducted for interested groups of janitors and firemen in which proper firing methods are demonstrated for smokeless operation. Many large real estate firms have cooperated splendidly with the department in this activity, requiring that all their janitors attend these classes.

On January 1, 1938, a new section was added to the smoke ordinance. This amendment provides for yearly inspections of all fuel burning equipment in Chicago. The purpose of this amendment is to detect boiler and furnace defects. The department has the power to deny any plant the right to operate until defective equipment is repaired or removed. This will result in eliminating the cause of much smoke in Chicago. Furthermore, owners of such defective boiler plants will benefit by the fact that repairing and renewing faulty equipment will result in more economical operation, reducing their annual fuel bills.

Ten years ago, the efforts of smoke abatement officials throughout the United States were directed only against visible smoke. Such emission was easily detectable and not very difficult of correction in most cases. In recent years, however, a great deal of attention has been devoted to the detection and abatement of dust and noxious sulphurous gases. These nuisances originate from many plants whose stacks appear to be operating smokelessly. The detection and cor-

(Continued on page 120)

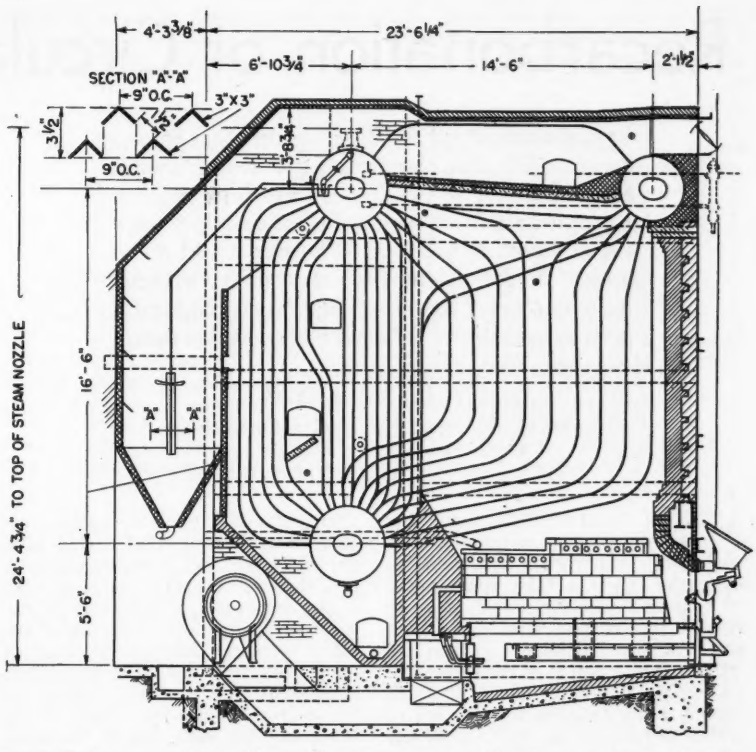


Fig. 4. Design approved for catching cinders from spreader stoker furnace serving water tube boiler

Average dust fall in Chicago by months in tons per square mile, 1934-1944
(This includes both water soluble and insoluble solids)

	1934	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944
January		85.7	88.0	117.3	56.1	52.3	47.3	56.3	56.4	63.8	68.3
February		72.1	95.5	144.6	50.66	76.4	41.7	68.7	44.4	79.0	77.4
March		127.0	110.3	103.6	79.2	83.7	52.2	52.9	63.0	90.9	80.2
April	107.7	111.9	86.9	82.9	82.1	60.4	47.8	63.4	54.4	68.1	57.5
May	156.8	58.1	70.7	75.7	60.69	79.5	59.6	84.2	63.2	77.7	73.6
June	147.1	52.4	74.5	67.1	59.1	68.9	53.7	55.9	58.0	90.3	74.7
July	94.8	44.3	48.5	87.2	74.7	47.7	58.5	44.3	63.8	85.4	61.5
August	67.0	42.4	85.9	68.9	70.9	45.1	49.3	43.9	67.1	70.0	60.2
September	79.2	39.1	46.3	60.4	62.7	76.9	66.7	61.0	43.6	64.8	60.0
October	66.9	47.0	64.6	70.4	65.3	82.7	69.0	56.4	46.4	65.3	62.3
November	69.43	67.6	104.6	66.5	69.9	58.2	67.2	36.1	59.8	60.2	60.7
December	78.6	62.4	116.2	52.4	53.7	57.3	36.5	42.0	44.4	68.5	61.8*
Average	96.39	67.50	81.17	85.60	65.4	65.8	54.1	55.4	57.0	73.7	66.5

* Estimated

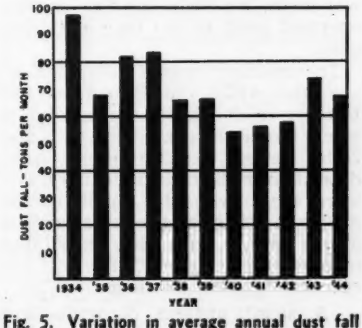


Fig. 5. Variation in average annual dust fall in city of Chicago during the period from 1934 to 1944

Recarbonation of Circulating Water

Recarbonation of cooling water to replace escaped CO_2 has completely prevented $CaCO_3$ scale deposits in condensers at Huey Station under load and water conditions existing since experiments began. . . . Whether it will do so under all conditions that may arise, without increasing recarbonation equipment capacity, is still a question . . . Results discussed in detail

By D. O. LIMA

Testing Engineer, Generation Department, Oklahoma Gas & Electric Co.

WHEN CONDENSER circulating water or other cooling water is cooled by evaporation and then recirculated, as in a lake, spray pond, or cooling tower the water tends to lose its free carbon dioxide and even some of the half-bound carbon dioxide. This action is of the same kind as, but less in degree than, that which occurs when temporary hardness of water is removed by boiling. If the water contains a considerable amount of calcium bicarbonate, and if the rate at which heat must be liberated from the water by evaporation is high enough, calcium carbonate scale will form on the heat transfer surfaces and insulate them. This, of course, is undesirable, particularly in the case of a surface condenser where a high vacuum is desired. To prevent this, recarbonation of the circulating water to replace the carbon dioxide has been employed in some cases. This article will detail a particular instance of its use.

The case here discussed is that of Belle Isle Lake, a 75-acre artifical lake in a creek bed at the edge of Oklahoma City. Up to Sept. 1943 this lake served to cool the circulating water for the Arthur S. Huey Memorial Station, at that time of 31,000-kw capacity, and also for the 9000-kw Belle Isle Station which was on standby most of the time. In Sept. 1943 a 20,000-kw unit was added at the Huey Station. Also, due to heavy war loads, the Belle Isle Station was operated much of the time after this date.

The resulting rate of heat input to the lake, which ran as high as 146 Btu per sq ft per hr average for a whole month, and as high as 170 for 24-hr periods, caused rapid scale deposition in the condenser tubes. We were faced with the possibility of having to acid clean the tubes perhaps 3 to 6 times a year, with undesirable outages for cleaning and loss in economy between cleanings.

A small amount of scale had formed in No. 1 condenser at times prior to 1943, and in 1938 it was acid cleaned. It was again acid cleaned in March, 1944, using 2000 gal of 28 per cent hydrochloric acid, and this was repeated in April with a like amount of acid because of the scale still remaining. The tops of the tubes were not completely freed of scale even after the second cleaning, because of the blanketing effect of the carbon dioxide gas liberated by the acid. The difficulty of removing all the scale from the tops of horizontal tubes could no doubt be remedied by circulating the acid solution very rapidly.

The average heat input rates by years up to 1943, and by months from then on are shown in Table I.

The heat rejected to circulating water in a condensing steam power plant, when no process steam is involved, may be computed accurately enough for the present purpose by the following simple formula:

$$B.E. - T.E. = H$$

Where: B.E. is per cent boiler efficiency,
T.E. is per cent overall station thermal efficiency,
H is per cent of total heat in fuel which is rejected to circulating water.

This formula gives proper credit for heat rejected by oil and air coolers, but not for any heated air escaping from the building nor for escaping steam.

In the hope that recarbonating the circulating water would replace the carbon dioxide lost from the water to an extent sufficient to materially reduce the scaling of the tubes, decision was made in March to try it, and equipment was assembled and finally put into operation on July 3, 1944. Carbon dioxide is absorbed by the water from boiler flue gas allowed to bubble upwards freely through the water.

Fortunately a heavy stream flow in the creek during March and April 1944, flushed the lake out and left it with a total alkalinity of only about 150 ppm expressed as calcium carbonate, all of this alkalinity being due to bicarbonates and none to carbonates. The total hardness was reduced to about the same value. This change in the water quality prevented any further scale deposition until recarbonation was begun.

Equipment

Flue gas from gas-fired boilers is pumped by a 200-cfm positive blower driven by a 7.5-hp motor. The flue gas is taken from a point above the rotors of regenerative air preheaters where the CO_2 is about 10.5 per cent, conducted through a partially insulated line, made from discarded 4-in. O.D. boiler tubes, a distance of about 150 ft to the blower. It enters the blower at about 150 F and with 10 per cent CO_2. From the blower it passes through a 4-in. I.D. cement-asbestos line laid underground a distance of another 110 ft to the circulating water intake.

At this point, steel headers distribute the gas to a grid of horizontal bubblers consisting of twelve 20-ft lengths of drilled 1¼-in. pipe, submerged 5½ ft under water a short distance ahead of the intake screens. The drilling consists of 1/16-in. holes spaced 0.9 in. apart. The holes face downward. The intake channel at this point is about 50 ft wide, and the bubbler pipes run crosswise of the channel and are spaced 2 ft apart.

The vacuum at the blower inlet is about 0.40 psi, half of which is due to pipe friction. The discharge pressure is about 3.0 psi, of which 2.4 is due to submergence of the bubbler pipes.

The size of gas bubbles produced

Table I. Heat Input to Lake in Btu per Hour per Square Foot of Lake Surface

1932	49.3	Jan 1943	68.7	Jan 1944	114.0
1933	37.5	Feb	72.5	Feb	137.1
1934	48.8	Mar	75.2	Mar	135.1
1935	55.6	Apr	71.3	Apr	94.9
1936	68.7	May	76.2	May	96.7
1937	76.6	June	88.3	June	101.6
1938	68.2	July	113.9	July	123.1
1939	74.0	Aug	118.3	Aug	126.2
1940	72.8	Sept	137.2	Sept	107.0
1941	70.3	Oct	145.7	Oct	120.9
1942	68.5	Nov	138.6	Nov	140.5
		Dec	142.9	Dec	155.2
				Jan 1945	163.8

Table II. Logarithmic Heat Transfer Coefficients—No. 1 Condenser

July 1943	606	May 1944	573
Aug	595	June	570
Sept	571	July	461
Oct	508	Aug	402
Nov	430	Sept	443
Dec	339	Oct	488
Jan 1944	319	Nov	487
Feb	259	Dec	467
Mar	273	Jan 1945	472
Apr	506		

varies from ¼ to ¾ in. in diameter. About 45 to 50 per cent of the CO_2 in the flue gas is absorbed by the circulating water.

The equipment operates continuously and has given very little trouble. About once a month it is necessary to raise the bubbler pipes to clean rust and algae growths out of the holes.

As soon as practicable the drilled pipes will be replaced with aluminum oxide diffuser tubes such as are generally used for sewage treatment. These, according to test, will produce ¼-in. and smaller bubbles and will permit absorption of 75 to 80 per cent of the CO_2 with only 4 ft submergence, and will furthermore be free from corrosion.

Results

The first inspection of the tubes after beginning recarbonation on July 3, was made on Sept. 3, 1944. No trace of new scale was found. On Oct 15, about 750 tubes were found plugged with pieces of scale which had come loose some time subsequent to the last acid cleaning. This spalling off of scale from the tops of the tubes may have been due to recarbonation or it may have been due to a delayed effect of the acid cleaning. All but 25 of the tubes were cleaned out mechanically. By Jan. 1, 1945, another 500 tubes were found plugged with scale and were cleaned out. Plugging of the tubes may continue and it may be necessary to resort to boring of the tubes as soon as an opportunity permits.

In spite of the tube stoppage, which has reduced circulating water flow from a normal of 38,000 gpm to as low as 28,000 average for the worst month and some remaining scale in the tops of the tubes, the average heat transfer coefficients for No. 1 condenser, based on logarithmic mean temperature difference, have been fair. See Table II. The bogey coefficient is about 600.

The amounts by which the condenser back pressures have exceeded bogey are shown in Table III. The high excesses for July and August 1944 were mainly due to algae or slime.

Number 2 condenser was not scaled up as badly as No. 1, and its scale appears to have been slightly reduced by recarbonation. When diffusers are installed it is hoped that it will clean up completely. Acid cleaning of this condenser has not been resorted to for two reasons. First, its heat transfer coefficient has remained reasonably good, and second, acid would probably destroy the protective paint originally applied to the steel tube sheets which were accepted as a war measure. It would be impossible to satisfactorily repair the paint if damaged.

The operating cost for recarbonation has been nominal and the installation cost was about the same as the expected cost of cleaning and of fuel loss for a 12-month period.

Water Quality

Makeup water to the lake not supplied by stream flow is first from deepwells and second from city mains. The well water has a calcium hardness of about 170 ppm and a total alkalinity of about 300 ppm, both in terms of calcium carbonate. During dry periods the well makeup rapidly increases the scaling tendency of the lake water.

When water loses any of its half-bound carbon dioxide, or in other words, when some of the soluble calcium bicarbonate is converted to the relatively insoluble calcium carbonate by loss of carbon dioxide, the water becomes alkaline to phenolphthalein indicator, because of an increase in pH. The phenolphthalein alkalinity of the lake water reaching the recarbonator has varied from 0 to 15 ppm, and leaving the recarbonator has been quite consistently 2 ppm lower. With 60,000 gpm of water flow this would indicate about 0.9 lb CO_2 absorption per minute. With 200 cfm of flue gas carrying 10 per cent CO_2 and 50 per cent of the CO_2 being absorbed, a rate of 1.0 lb CO_2 per minute is obtained. This is a satisfactory balance, considering the difficulty of exact phenolphthalein titrations on high bicarbonate water.

The high phenolphthalein alkalinities have been of only 2 or 3 days duration and appear to be associated with spasmodic vigorous growth of chlorophyl-bearing algae in the lake. These could be expected to extract carbon dioxide from the water. We have no explanation for their erratic growth, which at times gives the water a definite green tinge. Usually the phenolphthalein alkalinity has run from 4 to 6 ppm approaching the recarbonator.

Table IV is an analysis of the lake water as of Dec. 18, 1944.

Table V shows the average total alkalinity in terms of calcium carbonate of the lake water by months for 1943 and 1944. Hardness figures available are by the soap method and of uncertain accuracy, and are therefore not included.

The Langelier Saturation Index, which is computed from the pH of the water together with its calcium content, total alkalinity, and dissolved solids content, and which is supposed to indicate the tendency of a water to deposit calcium carbonate, has not seemed to hold true in the case of Belle Isle Lake water. When this index is zero or negative, the water should be non-scaling, and when positive, scale forming. The Langelier Index for Belle Isle water has been plus 0.8 without any evidence of scaling tendency. This tempts one to think that the effect of the absorbed CO_2 is transient and that it may inhibit deposition of calcium carbonate for a period of seconds or minutes when added in amounts too small to bring the Langelier Index to zero.

Conclusions

Recarbonation to replace some of the carbon dioxide which escapes from the cooling water has been effective in completely preventing calcium carbonate scale deposition in the Huey Station condensers under the load and water conditions which have existed since the experiment was begun. Whether scaling can be inhibited under all conditions which may be met at this plant without increasing the capacity of the recarbon-

(Continued on page 87)

Table III. Condenser Back Pressure—No. 1 Condenser

Excess Over Bogey In Inches Hg

July 1943	0.10	May 1944	0.00
Aug	0.13	June	0.09
Sept	0.29	July	0.46
Oct	0.24	Aug	0.57
Nov	0.27	Sept	0.34
Dec	0.44	Oct	0.22
Jan 1944	0.60	Nov	0.23
Feb	1.11	Dec	0.17
Mar	0.90	Jan 1945	0.20
Apr	0.05		

Table IV. Belle Isle Lake Water

Calcium—Ca	69 ppm
Magnesium—Mg	36 ppm
Sodium—Na	202 ppm
Carbonates—CO_3	5 ppm
Bicarbonates—HCO_3	377 ppm
Sulphates—SO_4	156 ppm
Chlorides—Cl	198 ppm
Total Hardness as $CaCO_3$	318 ppm
Total Alkalinity, $CaCO_3$	317 ppm
Langelier Index	Plus 0.7

Table V. Total Alkalinities of Lake Water

	1943	1944	1945
Jan	272	377	355
Feb	266	377	
Mar	260	394	
Apr	256	153	
May	150	207	
June	242	166	
July	290	187	
Aug	311	213	
Sept	299	270	
Oct	330	234	
Nov	357	317	
Dec	376	308	

Central Station Auxiliaries

A Discussion of Systems and Equipment

By H. N. Muller, Jr.

Central Station Engineer
Westinghouse Electric & Manufacturing Company
East Pittsburgh, Pa.

This discussion on central station auxiliaries is one of several presented at the Conference on Central Station Auxiliaries at the Winter Technical Meeting of The American Institute of Electrical Engineers. The purpose of this conference was to obtain an informal cross section of existing ideas regarding the design and operation of central station auxiliaries. Mr. Muller's discussion reflects the general opinion expressed at the conference and describes in considerable detail the features of modern electrical auxiliary systems.

DURING THE past few years power station auxiliaries and auxiliary systems have undergone changes which make discussion at the present most timely. The method of power supply has received extensive attention. The conventional radial system has received study in its various forms; loop systems and secondary network systems have come into the picture. While economics is always a consideration in selection of the power supply method, reliability has been the real keynote behind the search for alternate methods of supply. The apparatus itself has undergone changes, marked particularly by the change to air brakers and the trend towards air cooled transformers. The auxiliary motors themselves, and the associated motor starters have both had the designer's attention and will even better meet the needs of reliable auxiliary service. These facts are all indicative of the desire of the central station operator for maximum reliability. The ratio of importance to cost of the central station auxiliary system is high; probably not equalled in any other part of the power system.

The importance of each individual motor has been accentuated by the recent trend toward "unit type" station design. By "unit type" is meant the installation of boiler, turbine, generator and transformer as a unit without interconnection with similar units. Obviously, the failure of any major part can result in shutdown of the others, hence essential auxiliaries become doubly essential. For example, some stations will have only one induced draft fan per boiler, so that this drive must possess reliability as close to 100 per cent as can be obtained.

DISTRIBUTION SYSTEMS

Radial Power Supply

This type of system is well known to all engineers familiar with electrical design. The radial system has been studied in all of its various forms so many times, and by so many men, that the apparatus applications and feeder layouts are common knowledge. In the radial system the degree of reliability attained is a function of cost, and a very good performing system or a "skinny" system can be designed as a function of economics versus reliability.

Since there is comparatively little new to the radial system, further discussion here will be omitted. In later paragraphs, some of the apparatus application discussed will refer to the radial system, but individual description of design features is not warranted in this summary.

Network System Power Supply

A somewhat greater detailed description of the network system of distribution is warranted because of its relatively novel application to power plants. Many engineers are not cognizant of the different forms a network for auxiliary supply may take, and their familiarity with city secondary networks sometimes leads engineers to overlook these flexible arrangements applicable to central stations themselves. Some of the factors that may lead to the selection of a network system of auxiliary supply will be discussed in the following paragraphs.

The A-C secondary network system has been used for almost a quarter of a century in the commercial areas of some cities. During the last 3 or 4 yr the advantages of the secondary network system have begun to be recognized in the industrial field and the system has been installed in about 50 industrial plants.

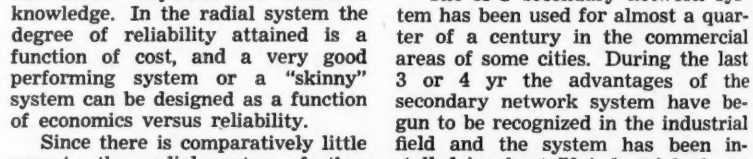


Fig. 1. Diagram of a typical a-c radial auxiliary distribution system

To date, however, the system has been used very little for supplying generating station auxiliaries. One installation operating at 120/208 v was made in a small station about 8 yr ago. Four installations operating at 460 v have been made during the last 4 yr. The performance of these 5 a-c secondary networks supplying generating station auxiliaries has been up to expectations.

A distribution system for supplying generating station auxiliaries should be reliable, flexible, simple to operate and maintain, and reasonable in cost. These four points will be very briefly analyzed.

The secondary network system provides maximum reliability and flexibility. The many years of experience with city network systems indicates that they are substantially as reliable as their source of supply and that they can be readily and economically expanded to take care of load growth. The network system is at least as simple as any type of system which will give somewhere near the same degree of reliability. The fact that any primary feeder together with its associated transformers can be removed from service without any interruption to service facilitates the operation, maintenance, and expansion of the system. Based on a number of careful economic studies, the investment cost of the network system has been found to vary from about 15 per cent more to about 14 per cent less than the cost of a radial system. In about 75 per cent of these studies the network system showed a saving of from 6 to 14 per cent. The result of any cost comparison will depend upon the form of network system used, and the form of radial system with which it is compared. If lesser reliability is accepted, a radial system can always be designed that is the cheapest usable scheme. The above figures refer to radial systems currently used and considered adequate.

The secondary network system may take the form of a grid, a loop, or one or more spot buses, depending upon the size and physical arrangement of the particular station. Each generating station is an individual problem and should be studied as such. It is therefore dangerous to generalize, however, based on detailed studies of about a dozen generating stations having one or more generators ranging in size from 10,000 to 150,000 kva, a number of things are indicated which may be of assistance in laying out a network system for any particular generating station.

(1) A secondary grid will usually give the best and most economical overall system, although in a small station a secondary loop or spot bus may be lower in cost.

(2) A 460 v secondary network is cheaper than a 208 v network, except possibly in very small stations.

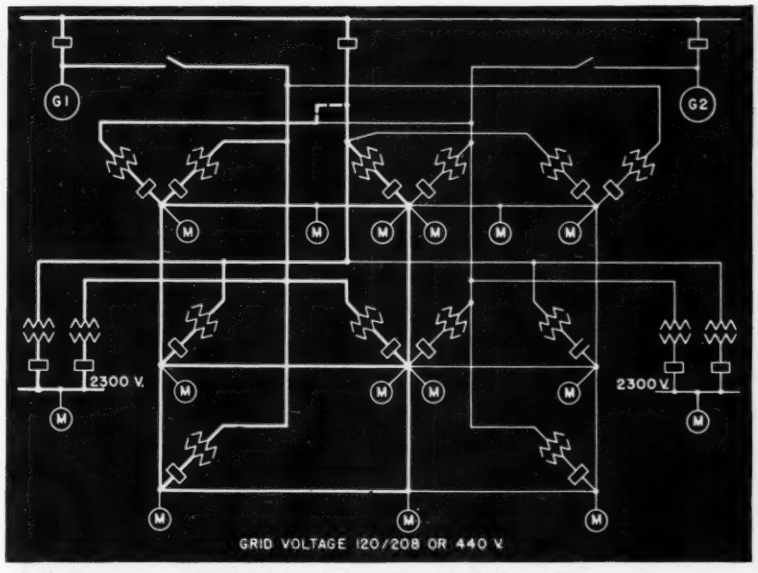


Fig. 2. A-C Network auxiliary distribution system

(3) Where the maximum size motor does not exceed about 600 hp, all auxiliaries should usually be supplied from a 460 v network. Motors above this figure should be supplied directly at 2300 v, or from a network (or networks) of this voltage, usually of the spot type. The same primary feeders can be used to supply both the 460 and 2300 v networks. If 208 v is considered for the secondary network it will be found economical in most cases to serve all motors above 50 or 75 hp at 2300 v.

The matter of short-circuit current on a secondary network is something that must be watched in designing the system, otherwise the fault currents may run considerably higher than on a radial system, and the cost of the load circuit breakers will become excessive. The following are methods of keeping the interrupting duty on the load circuit breakers down.

(1) Limit the amount of load on any one secondary grid or loop to a maximum of around 5000 or 6000 kva. This usually means a separate secondary grid or loop for each 100,000 kva of generating capacity or thereabouts, and less if small generators are involved and all load is supplied at low voltage.

(2) Where necessary, two or more separate secondary grids or loops can be supplied from the same group of primary feeders. The secondary networks preferably should be supplied over three or four primary feeders to keep the amount of spare network transformer capacity to a small value.

(3) The network transformers should have an inherent impedance of around 10 per cent. This high impedance has the additional advantage of improving load division between the transformers supplying a network, and in minimizing circulating currents between primary feeders whose voltages may be slightly different in magnitude and phase angle.

(4) If a spot network system is employed instead of a grid or loop form, the amount of load per spot bus should be kept down to 1500 to 2500 kva.

If the above points are kept in mind as guides when designing a network system for supplying power to generating station auxiliaries, the advantages of reliability, flexibility, and simplicity of this type of system can usually be obtained at less cost than those forms of radial system which will give somewhere near comparable reliability.

As stated, each generating station requires individual study. If the best system for a particular station is to be chosen, such study should be started early, before physical details of station design place limiting factors on the application of one type of system or the other. Whether new generation involves a new plant or simply additions to existing plant, of course affects the choice, although this fact is not necessarily limiting in itself.

Typical radial and network supply systems for central station plants are shown schematically in Figures 1 and 2 respectively.

MOTORS

Squirrel-cage motors with full voltage starting should be used wherever possible for driving constant speed auxiliaries because of the inherent reliability, simplicity and economy of both the motors and their control. Synchronous motors are not as desirable as squirrel-cage motors for essential auxiliaries because of the complication added by synchronizing control and a source of excitation. Their higher efficiency and power factor are of relatively minor

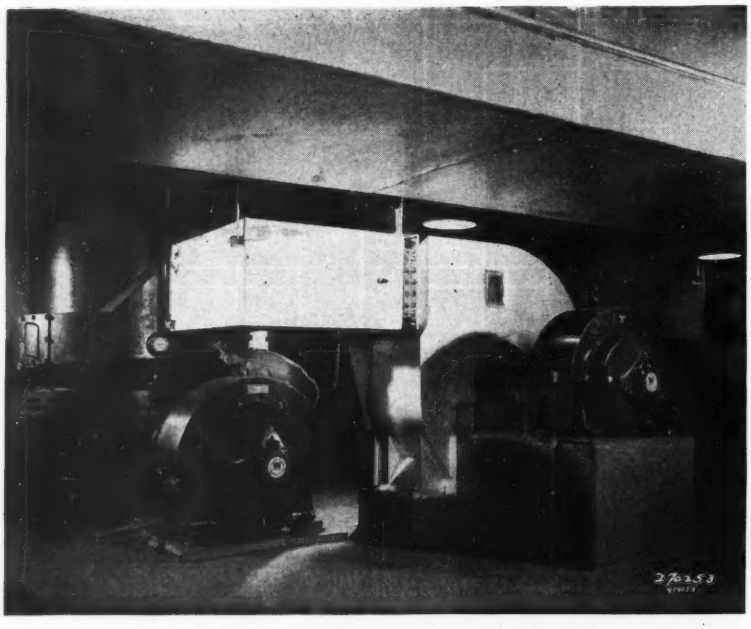


Fig. 3. Motor-driven pulverizer and fan in central station

importance because of the low cost of both real and reactive power at the generating plant bus.

Adjustable Speed Drives

There are several auxiliaries which require adjustable-speed drives. Cranes, coal bridges, and similar material-handling equipment can be driven best by wound-rotor induction motors. The most suitable electric drive for stokers is a series variable-voltage ac-dc drive. Boiler-feed pumps are usually driven at constant speed, but when speed adjustment is desired a wound-rotor induction motor with a multi-point drum furnishes adequate control.

Adjustable speed is very desirable for draft fan drives in order to reduce losses and erosion. Two speeds can be obtained with a pole-changing squirrel-cage motor, and this combination is frequently used with inlet-vane control. Thirteen or twenty speed steps can be obtained with a wound-rotor motor and drum, but this still requires the use of dampers or vanes for continuous control of gas flow. A squirrel-cage motor with a hydraulic coupling gives continuous speed control over about 4 to 1 range. The coupling requires cooling water, and involves extra bearings. Electric couplings do not require cooling water and give 10 to 1 speed range, but involve extra bearings, an excitation system and relatively high operating temperatures. A wound-rotor motor with a new type of liquid rheostat for secondary control has been used recently for large draft fans. This combination provides 3 to 1 speed range. It requires cooling water and an electrolyte, but eliminates extra bearings and rotating apparatus. The liquid rheostat appears to offer an attractive solution for future application.

The cost and efficiency of all of the above drives are comparable so that the choice of drive should be made primarily to give maximum reliability with the particular operating conditions which will be encountered.

Insulation

The insulation of motor windings for central station auxiliary service should be highly resistant to moisture, coal dust, and fly ash. Although the atmospheric conditions are no more severe than in many industrial plants the extreme importance of reliability of the auxiliaries requires the best possible insulation job. The smaller motors should be given ample varnish dips and bakes with carefully controlled viscosity and temperature, and the larger motors should be impregnated by the vacuum-pressure method. Mica insulation is to be used where practicable. The insulation between turns should be tested by a high-frequency testing set in addition to the conventional high potential tests between the winding and ground.

Rotor Design

Draft fans and some pulverizers have high inertia, and motors for these loads are best designed to limit the temperatures and expansion of the rotors to safe values. The WR^2 of each drive of this nature should be supplied to the motor designer for an analysis of the particular application. Certain types of pulverizers are subject to jamming and it is known from experience that operators may try several times to start them. Motors for these pulverizers require an extra margin in rotor thermal capacity. An ample air gap is especially desirable for motors on these two types of loads because of rotor expansion and should not be discouraged by unnecessary emphasis on high power factor.

Noise

The ambient noise level in most power plants is about 100 decibels in the general vicinity of the turbine and most of the auxiliaries. For this reason it is desirable to keep the noise level of all motors below this value. Windage and a siren effect produced by jets of air from the rotor vent ducts are the principal noise sources on large high-speed motors. The noise level on the very large 3600 rpm motors can be effectively reduced by the use of axial-flow surface cooling of the rotor, which eliminates the need for rotor vent ducts. A judicious selection of stator and rotor slot combinations will also reduce noise in addition to minimizing stray loss and parasitic torques.

Bearings

Either anti-friction or sleeve type bearings can be furnished today. Each type has its advantages and consequently is to be preferred for certain applications. The sleeve bearing has advantages for many general applications. It requires less precision work both in manufacture and maintenance, it inherently is suitable for operation in locations where coal dust and fly ash are present, and it can be operated at higher peripheral speeds. The anti-friction bearing may find preference because of smaller space requirements, because of its ability to take thrust loads, or because of the low starting friction inherent to its design. This last point refers particularly to vertical pump motors where heavy thrust is encountered.

Switchgear

As in all central station auxiliary devices, reliability is the outstanding qualification for switchgear for this service. Ease of installation and maintenance, and safety of operation for workmen are contributing qualifications desirable here as in other classes of service. These requirements are all met by up-to-date metal-clad gear in its various forms.

Air circuit breakers have virtually replaced oil for power plant auxiliary work. The switchgear for central station auxiliary service is built around air breakers, in practically all ratings up through the 15,000 v class. Various forms of high-voltage air breakers have been used since 1929, and all have given satisfactory operation. Their reliability is definitely proven. The many advantages of air interruption, particularly for this service, are well recognized, and consequently they are usually included today in the purchaser's specifications.

The reliability of metal-clad switchgear is now so well recognized that double breaker arrangements for

load circuits are seldom considered necessary and even auxiliary or transfer buses are not common. Special circuits may have double feeds usually from different breaker groups but duplication of breakers beyond this is not often justified. Where motors may require frequent starting, air breakers in metal-clad gear are well suited for this service.

Duplicate power supply, or normal and alternate power supply to auxiliary buses with automatic transfer is frequently provided. Relays for this function, and other normal protective functions, are mounted on the gear. Relays are preferably of the flexitest type with removable elements and built-in test switches. Functioning of all such control circuits is tested at the factory.

Switchgear for service voltages below 600 is now usually supplied with drawout breakers which have safety interlocking features which are similar to those in high voltage metal-clad switchgear. Increased use and improved manufacturing methods have brought the prices of drawout gear so close to the equivalent enclosed breakers with fixed mountings that the advantages of the removable breaker types easily justify the difference.

The low voltage breakers are available in all ratings to cover the necessary application to central station auxiliary drives. Interrupting ratings at 600 v go as high as 100,000 amp, and current ratings at high as 6000 amp at this highest interrupting rating. Low voltage breakers are often applied on the cascade principle, an arrangement which permits the lower breakers in the series to open fault currents in excess of their interrupting rating. Because of the limited selectivity which exists in cascaded circuits, the application of this arrangement in central station auxiliary service will seldom be found satisfactory. It will usually be necessary to make breaker applications in the same way that they are made with high voltage circuits, with all interrupters of adequate capacity for the faults to which they will be subjected. This will frequently mean that the cost of breakers for a given installation will be somewhat more, but it is the only way in which the essential full selective tripping on faults can be obtained. On non-essential auxiliaries, cascaded arrangements might be considered, but in general their application in central station auxiliary installations requires careful scrutiny.

Unit substations and power centers, usually with air-cooled transformers, form the most modern arrangement for supplying low voltage power. These assemblies may also include high voltage gear if the plant distribution system makes this arrangement desirable. The transformers used in network distribution arrangements can also be provided as parts of unit substations or power centers. A coordinated housing is provided which gives good uniform overall appearance and full accessibility to the transformers and switchgear.

There has been considerable discussion of the use of interrupters other than circuit breakers for protecting load circuits during high fault currents. High interrupting capacity contactors at 600 v and below, of the air-break variety, are now available. These are designed and rated in accordance with NEMA Standards. They are furnished with overload relays which provide thermal time delay characteristics suitable for motor starting and protection in combination with instantaneous trip to take care of short circuit conditions. The overload relays can be connected for alarm only on essential auxiliaries.

Still another idea has been receiving consideration to provide a motor starter which has a high interrupting capacity at a moderate cost. This is the combination of an oil immersed contactor with overload relays and a current limiting power fuse. These starters may be safely applied to 2300 v circuits having a short-circuit capacity of 150,000 kva and to 4600 v circuits having a short-circuit capacity of 250,000 kva. They are available with either 100 or 200 amp contactors.

For essential circuits, such as most power plant auxiliaries, it is believed that interrupting means that can be electrically or manually closed after fault clearing should be used. If an interrupter must be replaced after each short circuit, valuable time is lost that in the extreme case could be disastrous. For a few of the less essential auxiliary circuits, and particularly where short circuits are least likely to occur, the suggested combination starter can provide a very economical installation.

A blanket recommendation of this starter-and-fuse combination is impossible. Each case must stand on its own merits, or be discarded in favor of an air circuit breaker. If rapid restoration of service is of value in any given case, air breakers are dictated. If the available ratings of current limiting fuses do not completely satisfy the individual requirements, breakers are again the answer. Central station auxiliary service can be considered as the application requiring the utmost of dependability. As such, engineering and economics require very careful balancing before a decision to use the fuse and starter is reached.

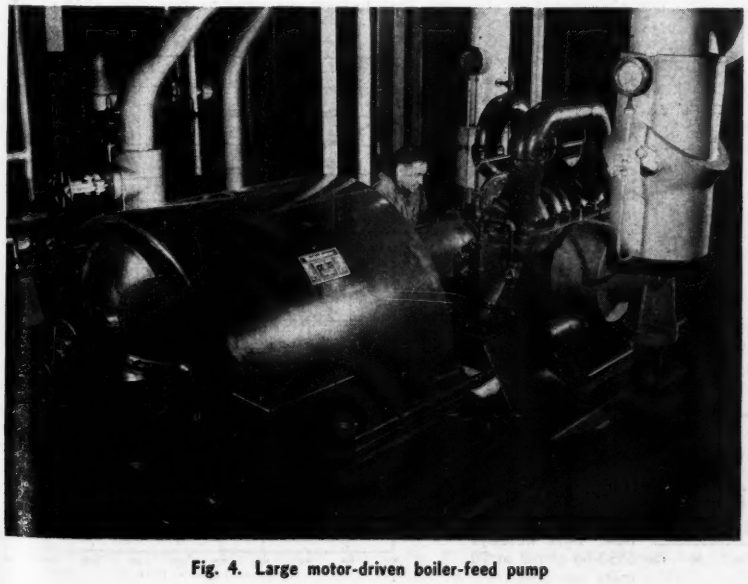


Fig. 4. Large motor-driven boiler-feed pump

Recarbonation of Circulating Water

(Continued from page 83)

ating equipment is still a question. During prolonged dry periods when no overflowing of the lake occurs, the concentrations of calcium and of total alkalinity may exceed any so far experienced, and the difficulty of holding calcium carbonate in solution while the water passes through the condensers will be correspondingly greater.

Other Applications

It would seem reasonable to expect that water which is cooled in spray pounds or cooling towers would also have its scaling tendencies reduced by recarbonation. In the absence of flue gas or exhaust gas of sufficiently high CO_2 content, carbon dioxide could be produced by burning coke or by burning limestone to produce quicklime and pure CO_2 but such schemes would greatly complicate the recarbonating plant and increase the costs. Industries which have pure CO_2 as a by-product, as in the fermentation industries, could recarbonate very cheaply because only a very small volume of gas would need to be pumped and the absorption of the CO_2 would approach 100 per cent.

A NEW STEAM TURBINE

Here are details and performance curves of the 6000-hp geared steam turbine locomotive recently built for the Pennsylvania Railroad by Westinghouse Electric & Mfg. Co. and The Baldwin Locomotive Works. It was delivered to the railroad in September, 1944. It is stated to be the first direct-drive turbine locomotive ever built in this country.

Fig. 1. Phantom diagram showing relative position of forward and reverse turbines with respect to locomotive driving wheels.

Fig. 2. General view of new Pennsylvania-Westinghouse-Baldwin steam turbine locomotive. This shows forward turbine, suspended on right hand side of locomotive frame between middle two driving wheels. Smaller turbine on left side of engine provides reverse power. Turbines drive two middle axles through double reduction gear and flexible cup-drive elements. Both turbines supported on gear case, which is supported from locomotive frame, making power unit self-contained assembly.

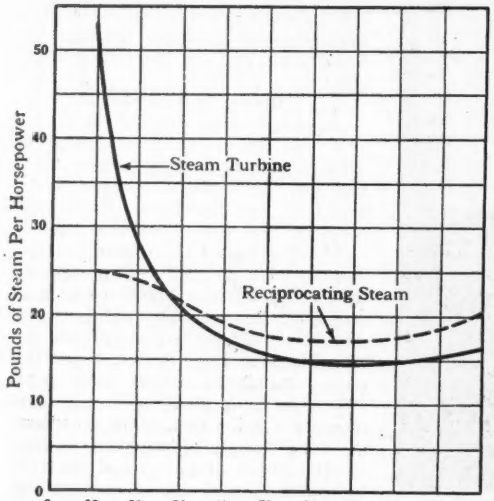
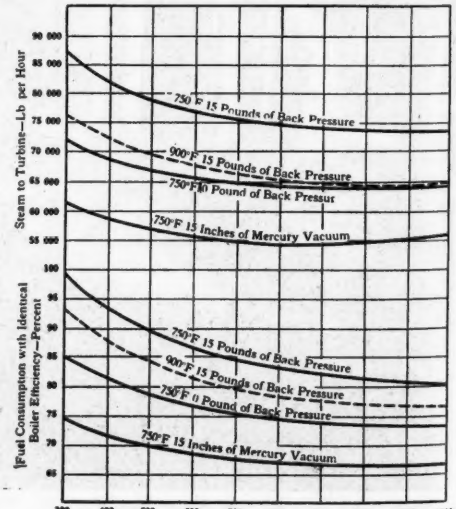


Fig. 3. Steam rate in pounds per horsepower at rail for steam turbine and reciprocating engine locomotives.

Fig. 4. Effect of steam conditions on fuel and steam consumption of 6000-hp steam turbine locomotive shown here. Engine shown has conventional fire-tube locomotive boiler, stoker-fired with coal and capable of supplying 95,000-lb of steam per hour at 310 psi gage boiler pressure and at 285 psi gage 750 F total temperature to turbine nozzles. With this steam flow, unit develops 6550-hp at rail at 70 miles per hour.



E LOCOMOTIVE

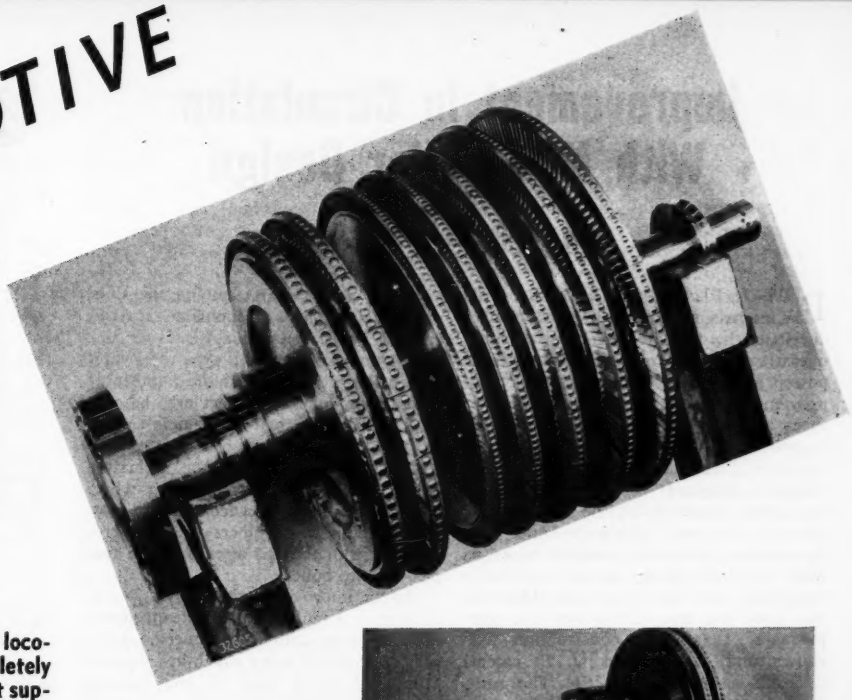


Fig. 5. Rotor of forward turbine, a six-stage non-condensing unit. Although especially designed for locomotive, it is similar to high-pressure units of cross-compound marine turbines. It consists of one Curtis stage followed by five full-admission Rateau stages. At 100 miles per hour speed, turbine speed is approximately 9000 rpm. Turbine exhausts at 15-psi gage, exhaust producing draft for boiler.

In this new steam turbine locomotive, the power unit is a completely self-contained assembly; 3-point support avoids transmitting distortion to the gear case; a single lever controls speed and forward and reverse motion; hardened and ground double-helical gearing is used commercially for the first time.

The gearing connecting turbines to axles is difficult to illustrate. It is a double reduction unit designed to transmit power to No. 2 and 3 axles from a single high-speed pinion. Side rods connect the four drive wheels on each side to transmit equal torques. The gear is of the nested type with two double helical high speed gears, two low speed spur pinions, two low speed spur gears and two cup drive elements, all in an enclosed gear case. The cup drive permits the driving axles to move vertically with respect to the gears.

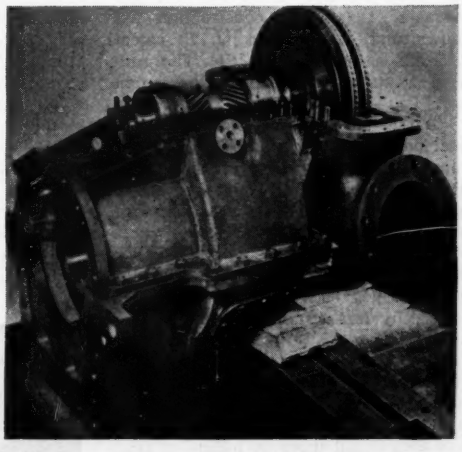


Fig. 6. Overhung on extension of reverse gear pinion shaft, reversing turbine consists of single Curtis stage of 1500-hp capacity, taking steam at 285 psi, 750 F, maximum operating speed 8300 rpm. Reverse speed of locomotive limited to 22 miles per hour by supplementary reduction gears. If locomotive overspeeds (110 mph forward or 25 mph in reverse) or lubricating oil pressure falls below 5-psi, control air actuating steam flow valve is exhausted to atmosphere.

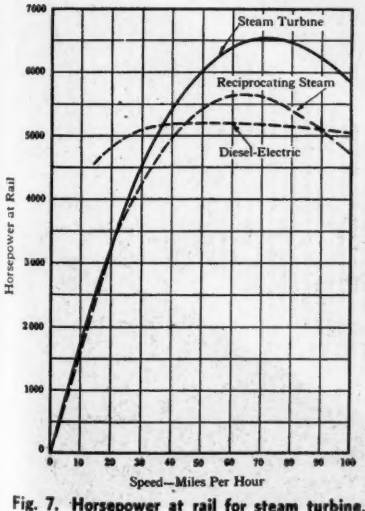


Fig. 7. Horsepower at rail for steam turbine, reciprocating steam and Diesel-electric locomotives.

Fig. 8. When hand lever is in "low," reversing clutch is engaged. "Neutral" is the off position and "intermediate" allows steam to flow to forward turbine.

Improvement in Circulation With New Boiler Design

By J. R. DARNELL

POWER PLANT ENGINEERS will be interested in a new design of boiler developed by Carl E. Stromquist, chief operating engineer of a large industrial power plant. This boiler embodies improvements in the arrangement of the tubes and headers in such a manner as to provide increased circulation and to facilitate dust removal. Although particularly designed for utilizing waste heat from cement kilns, the rapid circulation of the water within the boiler and its excellent steaming qualities make it ideal for direct firing, particularly with pulverized coal where large quantities of ash dust are carried through the gas passages. Details of construction are shown and described in U. S. patent 2,358,358, issued Sept. 19, 1944. The principal features, as stated in the patent are:

"First—the utilization of straight vertical boiler tubes, economizer tubes, and superheater tubes. This is to prevent dust from lodging on the tubes, which in the case of the usual horizontal or inclined tubes insulates the upper area of the tubes, thus reducing the effective heating surface, to prevent blocking the gas passages between adjacent tubes caused by dust accumulation in the form of bridges.

"Second—the provision of a sectional tube header. This is to facilitate the dislodgment of dust from the lower headers and to permit access to the entire area of all tubes by means of lancing apparatus entered between the upper headers.

"Third—the provision of means to induce a rapid water circulation. Water circulation is accelerated by means of downcomer tubes, located outside of the direct gas passage. This provides a rapid equalization of temperature of all surfaces of the boiler corresponding with the developed pressure when quickly subjected to the heat of the incoming gas discharged from the kiln, thus eliminating excessive strain from unequal expansion.

"Fourth—the provision of improved dust control apparatus. The usual type of mechanical soot blowers are inadequate for properly dislodging the dust in waste heat boilers used in connection with cement kilns."

The most important feature of this boiler is the improvement in the circulation of the water. The principal defect in the design of most boilers is that all of the water in circulation must pass through the steam drum. Since the release of steam from the various tubes is not uniform, the resultant turbulence not only causes wet steam but the sluggish circulation is responsible for increased fuel consumption.

In the conventional type of water tube boiler, regardless of the number of tubes, their combined effect may be considered the equivalent of a single U-tube in which the natural thermosyphonic circulation is retarded by the formation of steam bubbles in the cool leg which corresponds to the downcomers. In most boilers these downcomers are subjected to heat from the gas stream in the rear pass of the boiler.

In the improved design shown in Fig. 1, there is a multiplicity of steam generating sections with interconnected adjacent downcomer tubes which are shielded from the direct heat of the furnace gases. By means of upper and lower water boxes, each section is connected to the boiler drum in such manner that only a small portion of the total water in the boiler momentarily flows through the drum which merely acts as an equalizing reservoir for the upper water boxes from which the steam is liberated.

Figure 2 is an end elevation at the point where the gases enter the tube bank. The numerals 13 are the steam generating tubes. The downcomer tubes 29 are protected from the heat of the gases by side walls 18. The downcomers connect with upper water boxes 30 and lower boxes 22. Boxes 22 connect with headers 14 by means of nipples 25 while boxes 30, at the top, connect with headers 31 by means of nipples 32. Dust Chamber 15 is shown below the tube bank.

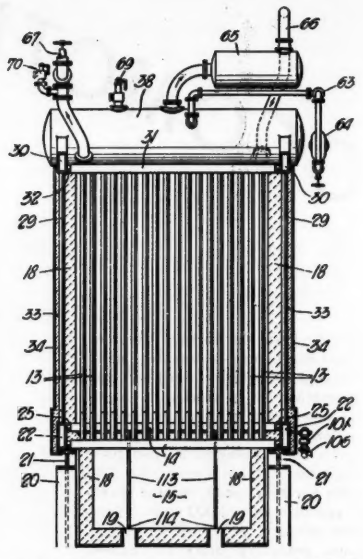


Fig. 2 End elevation of boiler shown in Fig. 1 at point where gases enter tube bank

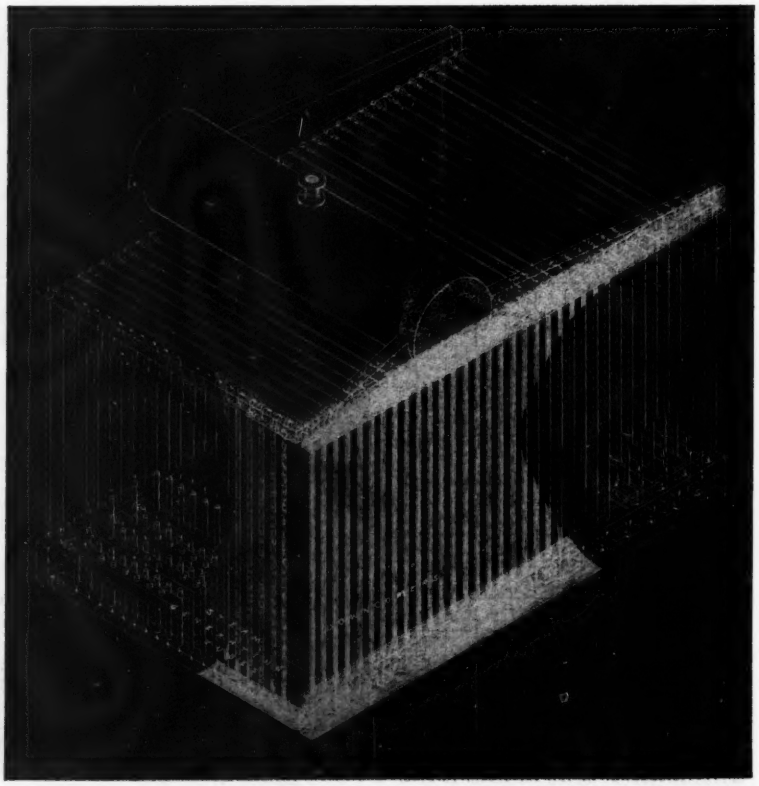


Fig. 1 Perspective view of new, patented, single-pass boiler designed for improved circulation

[1] Markson, Ravese and Humphreys — A Method of Estimating the Circulation in Steam Boiler Furnace Circuits, Trans. ASME, May, 1942, pp.

Grand Coulee

(Continued from page 71)

table from 4 to 10 seconds for the complete stroke.

Generators

The six main 108,000-kva generators, the two Shasta 75,000-kva generators, and the two 10,000-kw, 12,500-kva station-service generators are all of the vertical-shaft type, being totally enclosed and water-cooled.

The six 108,000-kva units generate at 13.8-kv, 3-phase, 60-cycles. These generators are cooled by means of air circulating within the machine housing, through eight surface coolers, connected to the outside of the stator frame. Fan blades on the lower side of the rotor circulate air out through the coolers, up over the top of the stator and then through the stator and rotor windings. Cooling water is supplied from the tail-bay by means of hydraulic jet-pumps, and is fed to the coolers at a pressure of about 35 psi.

Separate Exciters

Excitation is supplied from seperately-driven exciters, in contrast to the normal method of using exciters connected directly to the generator shaft. Each generator is provided with a 400-kw, 250-v direct-current exciter, driven by a 600-hp, 6900-v, synchronous motor, power being supplied from the station-service generators. On the same shaft with the motor and exciter, there is a 10-kw, 250-v pilot exciter, which supplies field current for both the main exciter and synchronous motor.

Only the present six main units will be provided with seperate exciters, as these machines will ultimately be used for driving pumps for the irrigation system. With such an arrangement, it is planned to apply excitation to a generator and to its one or two connected pump motors, at standstill, and then bring both up to speed, locked in synchronism. The synchronous motor of the exciter set has a pull-out torque of not less than 250 per cent of normal full load torque, in order to prevent loss of synchronism and subsequent loss of generator excitation if the station-service voltage drops suddenly because of a momentary fault in some other station-service feeder.

The voltage on the main generator is regulated by means of type BJ-30 voltage regulators, which control motor-operated rheostats in the main exciter field circuits. High-speed relays operate during severe voltage disturbance, to cause large changes of main-exciter field current, and thereby help to restore normal generator voltage rapidly. Each main exciter is equipped with a differential field which opposes the normal field for the purpose of reducing the exciter residual voltage to zero.

Generator Stator Details

The stator frames are 37 ft in diam, and 9 ft 9 in. high. With the exception of one generator, they were shipped in four sections, the windings being complete on each section, except for the turns to span the joints. The sections were bolted together and the remaining windings were installed on the project. In order to relieve congestion at the factory, the stator sections for one machine were shipped with no windings installed, and all windings were put in place after the sections were bolted together.

The stator windings are connected three-phase star, the neutral point being ungrounded except through a ground-detector potential transformer which is inserted between the neutral point and ground. Each phase of the stator winding is split and a current transformer is provided in each half, for differential relays which protect the windings against internal faults.

All coil ends were painted with a special corona-shielding paint, to reduce the corona effect as much as possible. After the stator winding was complete, it was given a high potential test of 28,600 v, alternating current, to check any possible insulation weaknesses.

Generator Rotor Details

The rotors were fabricated entirely on the project, as shipment of the 537-ton piece as a unit would have been impossible. The rotor shaft was first mounted and plumbed on a specially constructed base, after which the cast steel spider was heated and then shrunk onto the shaft. The stacking of the laminated steel rim followed, and the rotor was then completed by installing the sixty field poles, the cores of which are dovetailed into the laminated steel rim. Each pole of the first three main-unit generators has a short-circuited damper or amortisseur winding in the pole face. Interconnected damper windings were provided on the rotors of the second three main unit generators, since they afford better characteristics during system disturbances. All field-pole windings are connected in series, and the two end leads are brought out to two insulated collector rings mounted on the shaft, above the rotor and below the oil reservoir for the thrust- and upper guide-bearings.

The complete rotating portion of the unit, which includes the rotor, intermediate shaft, and the turbine shaft and runner is supported by a segmented type thrust bearing, located at the top of the machine. There are eight babbited stationary thrust-bearing segments, mounted on pivots in such a manner that together they form a circle around the shaft, with an outside diam of 8 ft. A cast iron thrust-bearing runner is keyed to the shaft, and rests directly on the eight babbited segments. The complete bearing is immersed in a bath of 1600 gallons of oil, which is cooled by means of water circulated through a copper coil inside the oil pot. On three of the six units, electric strain gauges, installed in the supports of the segments of the thrust bearings, determine accurately when the load of the rotating element is distributed evenly among the thrust shoes. This addition is a decided improvement over previous methods of equalizing the thrust-bearing load.

In addition to the thrust bearing, there are three guide bearings, one combined with the thrust bearing, and installed in the same oil bath. One is located just below the rotor, and is designated as the generator lower guide bearing. The third guide bearing is part of the turbine, and is located just above the turbine runner. The first two run in an oil bath, while the turbine guide is lubricated by oil under pressure, supplied by a ½-hp alternating-current pump, with a similar direct-current pump for emergency. This bearing is of the babbitted shell type, and is formed in halves.

Generator Fire Protection

For fire protection, provision is made for automatically or manually releasing liquid carbon dioxide into the generator housing from twenty-four 50-lb cylinders. The operation of generator- or split-winding differential-relays, or the closing of thermostats within the generator housing automatically discharges the carbon dioxide, which prevents burning and damaging of the windings. In order to reduce the amount of carbon dioxide kept in readiness, each group of three generators is served by only one bank of cylinders. On operation, proper routing valves are automatically opened so that the gas will be discharged into the right machine.

The two station-service generators are very similar in construction to the main units. The greater part of the station-service power is distributed at the generated voltage of 6,900. A total transformer capacity of 6,000 kva is provided for operating the 460-v station auxiliaries. The excitation for the station-service generator is supplied by direct-connected pilot and main exciters.

Shasta Generators

There is very little difference in electrical construction between the two 75,000-kva Shasta generators which are temporarily installed in Grand Coulee Power Plant and the 108,000-kva units. However, they rotate counterclockwise as viewed from above, and have direct-connected pilot and main exciters. The bearings being of the multiple-spring type are the main items of difference. The thrust bearing is a ring, the top of which is babbitted and grooved ra-

dially for the admission of oil. This ring rests on a large number of heavy springs, which allow enough movement of the bearing ring to conform to the runner plate above it. The upper guide bearing is located just below the thrust bearing, and above the collector rings. The lower guide bearing is immersed in an oil bath, as are the thrust and upper guide bearings, while the turbine guide bearing is lubricated by a forced-feed oiling system.

Control System

The first point of control of the units is at the unit control boards, one for each unit, located in the governor gallery at elevation 951. These boards are adjacent to the governor actuator cabinets, and adjoin the 460-v unit-auxiliary power boards. On these boards are mounted the protective differential relays for the generators, the exciter control and meters, the generator voltage-regulators, and generator meters.

Duplicate metering for all generators is provided on the main benchboard in the control room, Fig. 7, located on the top floor of the control building. Once a machine has been brought up to speed and voltage, it is turned over to the control-room operator, who synchronizes the generator to the buses and adjusts load and frequency. Automatic equipment is provided for controlling load and frequency. It is operated from a master clock for automatic adjustment of frequency, for control of system feeder connections, and as a means of making electric clocks on the system reliable timekeepers.

Remote control of all circuit breakers in the switchyard, about one mile distant, and metering of all power deliveries to transmission lines at the yard, are provided on the main-control benchboard. Metering and relaying over this distance is accomplished with transformers with one-ampere secondary current, which permits the use of standard control conductors, equivalent to approximately No. 9 wire gauge, for current-transformer circuits, whereas standard transformers with five-ampere secondary current would have required 500,000-circular-mil copper conductors to reduce burden to the same figure. In the power house, the current circuits are again transformed to five amperes, in order to use standard meters and relays.

Annunciators at control stations show the occurrence and location of electric troubles such as abnormal temperature rises and interruptions of water circulation in vital lines. An acid-type, 120-cell storage battery furnishes energy for the operation of control and relay systems.

The station-service power plant supplies energy for light, power, and heat in the power houses, pumping plant, and dam, for public and domestic uses in the village, and for exciting the six main generators; and they will eventually drive the exciters of the pump motors.

Communication Facilities

Telephone communication between all important points on the project is provided by an automatic telephone system, which, however, includes a private-branch-exchange board, where one operator is in constant attendance during the usual work day, to receive incoming calls from the town central office, and to assist in completing calls when the automatic equipment does not function properly or when mistakes are made in dialing. At other times, these functions are performed by the main-control-room operators from their desk-type, cordless telephone boards. A supplementary, manually operated common-battery system for emergency use extends to vital points in the power house and switchyard, and terminates on the two duplicate cordless boards in the main control room. A code-call system, with bells effectively covering the dam, power houses and switchyards, can be operated from any telephone, and the call can be answered at any other telephone.

For communication with substations and other power plants on the power transmission system, three telephone carrier-current channels, operating at 73.75, 85, and 135 kilocycles, are in use at present, with a fourth expected soon to be placed in operation. These carrier-current circuits terminate on both the control boards and the private-branch-exchange board, and connections may be made to any project telephone through the latter. On one frequency, carrier sets with an output of only 20 watts perform very satisfactorily over a distance of 183 miles. On others, where the signal must go through substations and switching equipment, 150-watt sets are used. Single-and-double-frequency wave-traps, connected into the outgoing lines, next to the circuit breakers, have been found effective in preventing carrier signals from being dissipated in local equipment. Although not normally used, five carrier relaying sets in parallel with the telephone carriers are arranged for communication in case of emergencies.

Transformation and Switching

The power plant is laid out on what is called the "unit system," each generator having its own transformer bank, the output being paralleled with other generators only on the high-voltage switchyard bus. A unit can be operated independently on a transmission line in certain emergencies. Each main-unit generator delivers its output through a bank of three single-phase, 36,000-kva oil-immersed, water-cooled, inert-gas-filled transformers, with 13,600-v delta-connected primaries. The secondary windings are Y-connected, to produce a line voltage of 230,000-v. One bank of 3 transformers is provided with both 115,000 and 230,000-v, Y-connected, full-capacity secondary windings, so as to deliver the output from that generator at either or both of these voltages, or to permit the transfer of energy from one system-voltage to another, with the generating unit disconnected.

The neutrals of the high-voltage lines may be grounded solidly, or may be ungrounded by neutral disconnecting switches, with over-voltage protection provided by a lightning arrester from the neutral point to ground. This ungrounding of the transformer neutrals is provided for the purpose of reducing fault-currents from single line-to-ground faults to the same magnitude as currents produced by other types of faults, thereby reducing the interrupting duty required of the line circuit breakers. This is accomplished by ungrounding the neutrals of two transformer banks when four banks are bussed together.

Transformer Construction

Five of the main-unit banks of transformers are of core-type construction. The two banks of 25,000-kva transformers for the units which were borrowed from Shasta Power Plant are of similar construction. One main bank of 36,000-kva transformers, is of shell-type construction, with forced circulation of insulating oil. The transformers are located on a deck between the dam and power house, where provisions are made for moving them, on their own trucks and a transfer car, between their installed positions and a service bay in the power house, or to spare positions on the transformer deck.

Connections from the generator terminals to the transformers are made by enclosed, isolated-phase buses, passing through openings in the wall of the structure, along the upstream side of the power house. Provisions are made on the bus structure, from each of the first six generators in the left power house, for connections through disconnecting switches to future circuits to the pumping plant, where two 65,000-hp motor-driven pumps will be connected through oil circuit breakers to the leads from each generator.

Lightning Arresters and De-icing Switches

Lightning arresters for the high-voltage connections to each transformer bank are suspended from structural steel supports on the adjacent slope of the dam, and are connected to the high-voltage lines through disconnecting switches, which are mounted on structural steel supports built over the transformer transfer tracks. The high-voltage conductors extend from anchors on these structural steel supports to take-off structures on the power house roof, and thence to the switchyard, about one mile distant, at the west end of the dam. A similar switchyard will be provided near the right end of the dam for the right power house.

(Continued on page 118)

The PRACTICAL ENGINEER and ELECTRICIAN

ANDREW W. KRAMER, EDITOR

HE'S NOT UBIQUITOUS

ONE of our readers in telling about some of his troubles expressed his great need for a warning device in his refrigerating plant. "Does anybody," he asks, "make a warning device that will go off when the ice machine is running below temperature? I haven't got a man in the outfit that understands this refrigerating equipment and I have to keep my eye on the dial all the time. The first week I took over the job of running this hotel plant, I was so busy getting settled that I forgot the darn thing for a while and while I was attending to other matters the darn system froze up and we lost about 100 lb of meat in the boxes. Boy! Just imagine the howl that would go up if that ever happened these days. It is a tough job trying to keep track of a thing like that and at the same time doing all the running around an engineer in a hotel has to do these days. Some kind of a warning system with a light or bell or both that would let me know when a critical condition was reached would be a great help."

It's a simple request but if anyone reading this can suggest a device of this kind we will be glad to pass the information on to our hotel friend.

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The Meaning And Use of ENTROPY

In scores of books and in hundreds of articles attempts have been made to explain the term entropy in non-mathematical language; all sorts of diagrams have been drawn to give the practical operator a mental picture of entropy, yet, despite all these efforts, the meaning of the term is still obscure to many engineers. This article by Mr. Hicks does not attempt to "picture" entropy; it merely explains that it is a factor which permits a more practical diagram of the heat received by a substance to be drawn and points out the analogous relationships with other terms more understandable

By Tyler Hicks

OPERATING MEN are sometimes inclined to look upon entropy as being a very theoretical property of a fluid. On the contrary, a thorough understanding of the meaning of the word will open a huge field of power engineering calculations. This article is designed to point out the analogous relationship which exists between entropy and other readily understandable, and more palpable quantities.

All energy changes can be mathematically expressed as the product of two factors and may be represented on paper by means of the area of a graph. One factor is laid off on a vertical scale (ordinates) and the other on a horizontal scale (abscissae). If, as in Fig. 1, the resulting graph is a rectangle, its area is equal to the product of the base and the altitude. For the case illustrated, where the distance is 6 — 2 or 4.

Work = Force × Distance
W = 5 x 4 = 20 ft lb
Area = Base × Altitude,
A = 4 x 5 ×20 square units

Similarly, the work done by a gas on a piston may be represented as shown in Fig 2.

Work = average absolute pressure × change in volume, or
$W = P\ (v_2 - v_1)$

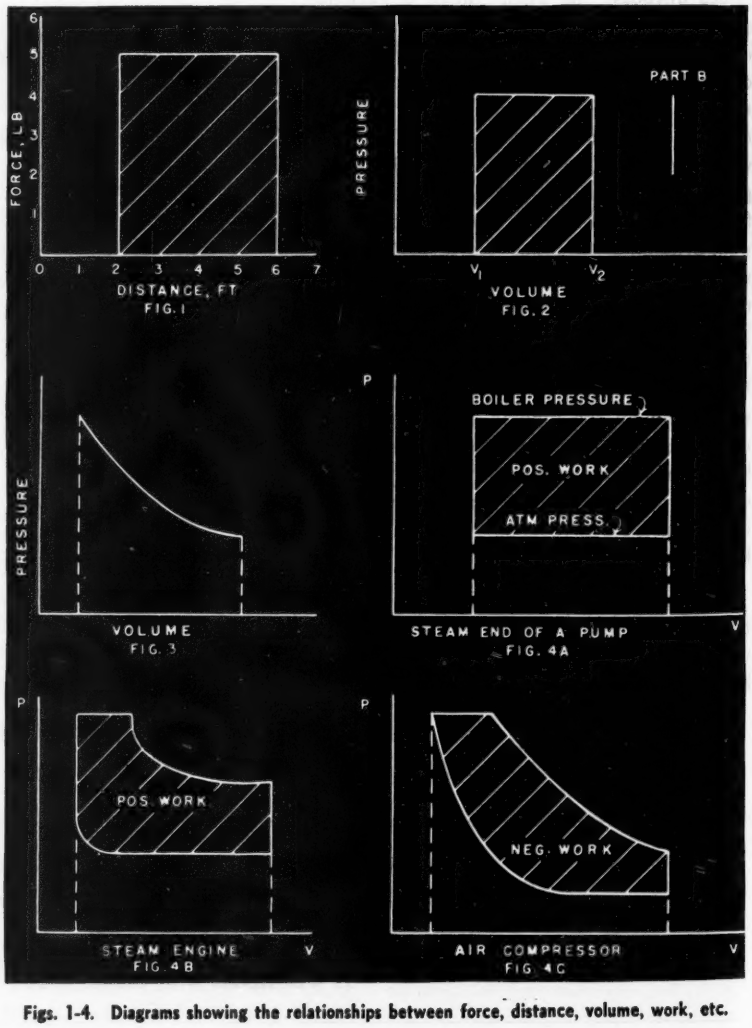
This diagram shows that the work done on the piston (often called positive work) is also equal to the product of two factors. If the piston does work on the gas, such as in the conventional air compressor or compression refrigerating machine, then the diagram graphically depicts the work done by the piston. This is often termed negative work, because the final volume of the gas is less than the original volume. Assuming that the piston remained stationary and that the gas pressure was increased, no work would be done on the piston because the product of the absolute pressure and the change in volume would be zero. This is shown in part B of Fig. 2.

As all power engineers know, the P-V relations in an engine cylinder are always represented by a curve, Fig. 3. As before, the area under this curve is equal to the positive or negative work performed on the piston. Figures 4A, B and C shows P-V diagrams for some common power plant equipment. In each case the total area represents the work put into the machine, while the area enclosed in heavy lines shows the work which it is able to perform. The positive or negative work is most frequently expressed in foot-pounds. It is the work which is available at the crankshaft, in the air tank, or in the water end of a pump.

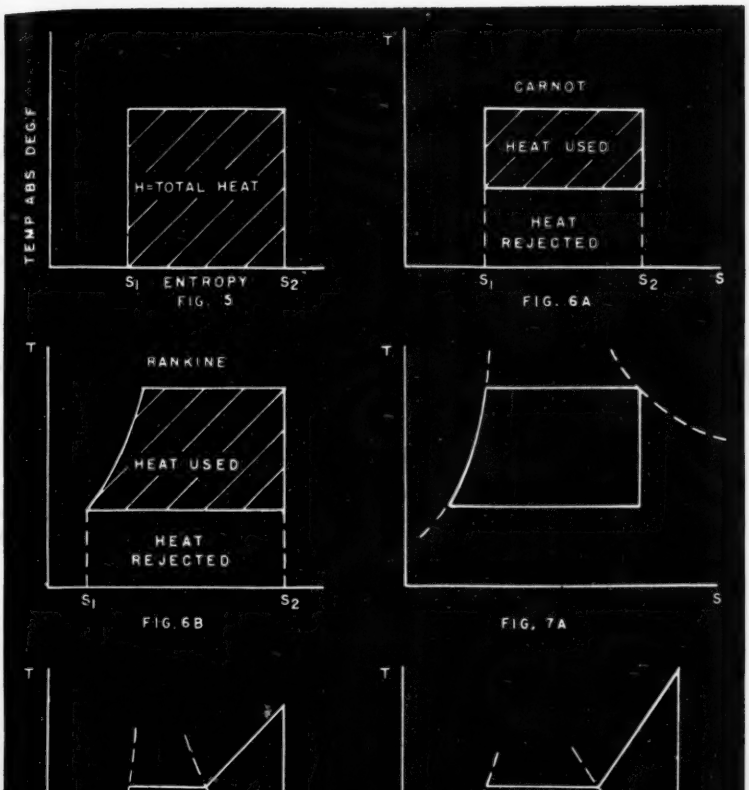
The thermal efficiency of a heat engine is expressed as follows:

$$\text{Efficiency} = \frac{\text{Heat converted into work}}{\text{Total heat supplied}} \qquad (1)$$

Using the same reasoning as that employed when explaining the P-V diagram, it can be shown that if a diagram can be drawn showing the two quantities in formula (1), the efficiency of the heat engine may be readily determined. To accomplish this entropy is used. Letting the ordinates represent absolute temperatures and the abscissae, entropy, Fig. 5 is drawn. The area of this



Figs. 1-4. Diagrams showing the relationships between force, distance, volume, work, etc.



Figs. 5-7. Diagrams illustrating entropy and its application in the study of various heat cycles

rectagle will represent the total heat received, just as the areas in Fig 4 show the total work done. In order to have a product of T, the temperature, and another factor which will equal the total heat supplied to the machine, entropy is introduced. This leads to the statement that entropy is a factor which permits a more practical diagram of heat received to be drawn. Thus, entropy reduces the amount of work necessary in heat calculations. It is possible to determine the thermal efficiency of a machine from its P-V diagram, but the calculations required are much longer than those required if entropy is used.

In this article the term "total heat" is used. Latest published steam tables list the total heat under the heading "enthalpy." The terms "total heat" and "enthalpy" mean essentially the same thing. Enthalpy is a trifle more accurate when certain factors are considered, but "total heat' is easier to understand. The only difference between the two terms lies in the means to use the same goal, namely, the total heat of a substance at a given pressure. The term "enthalpy" need not confuse you; just think of it as "total heat."

In order to more fully understand the meaning of the word, the following value for entropy may be derived.

$$T\,(S) = H,$$

or S = entropy = H/T

H = total heat, Btu

T = abs temp, Deg F

In words, entropy is the heat energy transfer to or from a substance per degree of absolute temperature. Note the analogy between the products PV and TS.

Operating engineers generally deal with steam which is first at one temperature and pressure and then at another. Bleed points on a turbine and the exhaust of the heaters supplied from these points are an illustration of this statement. Reference to steam tables will show that entropy changes with the absolute pressure. Also, carrying the analogy between PV and TS diagrams further, it may be inferred that since the total heat supplied is represented on a TS diagram by an area, a change of entropy is necessary to secure this product. For the present only change of entropy is of interest. Using these ideas, the total heat shown by Fig. 5 would equal:

$$H = \text{abs temp}, F \times (S_2 - S_1) \quad (2)$$

Figure 6 shows TS diagrams for the Carnot and Rankine cycles.

The Carnot cycle efficiency is the greatest that may be attained by any heat engine operating between two given temperatures. Thus, if the initial and final temperatures of a substance used in a power cycle are known, the maximum efficiency can be shown to be:

$$E = \frac{T_1 - T_2}{T_1} \quad (3)$$

This formula may be easily derived by using the areas for positive and negative work shown in Fig. 6. It would be good practice for the reader to do this.

The Rankine cycle is standard for vapor heat engines such as the steam engine and the turbine. Its maximum efficiency is always less than that of a Carnot engine operating between the same temperatures. That this is true can be seen by comparing the two areas in Fig. 6, assuming the same initial and final temperatures. The efficiency of the Rankine cycle is:

$$E = \frac{H_1 - H_2}{H_1 - h_2} \quad (4)$$

where,

H_1 = total heat of steam leaving boiler

H_2 = total heat of steam entering the condenser

h_2 = heat of liquid at temp. of condensation

There are three possible diagrams of the Rankine cycle. Each corresponds to a different degree of superheat of the vapor as shown in Figs. 7A, B and C.

An example will illustrate one way in which the formulas and principles developed in this article may aid the operating engineer.

What would be the Rankine cycle efficiency for a steam plant in which the boiler delivers steam at 150 psi abs to the prime mover and in which the condenser pressure is 1 psi abs? Using the steam tables and formula (4);

$$E = \frac{1194.1 - 872}{1194.1 - 69.7} = 28.4 \text{ per cent}$$

What is the efficiency of a Carnot cycle operating between the same temperatures?

$$E = \frac{358 - 101}{358 + 460} = 31.5 \text{ per cent}$$

Thus, there is a difference of 3.1 per cent in the efficiency.

Using his knowledge of other aspects of power engineering the operating engineer may bring them all together in order to track down losses in his plant. The following is a suggested program.

1. Determine the maximum efficiency of his plant by means of the Rankine relation.

2. From an indicator diagram or from the turbogenerator output (after the generator losses are taken into consideration), determine the actual thermal efficiency of the prime mover. It is here assumed that the operator is familiar with the use of conversion factors between work and heat. Difference between this value and the Rankine cycle will yield the losses in the prime mover.

3. By determining losses in the boilers, piping, and auxiliary apparatus, a complete heat balance of the plant may be drawn up.

4. Comparison of the losses with generally accepted values will reveal any wide variations. If descrepancies do exist, further investigation of the particular part of the cycle involved should be carried out.

It can thus be seen that with the correct combination of "figuring" and practical mechanical work, the efficiency of the average power plant can be made more nearly equal to the theoretical limiting value. The results, of course, are obvious.

PRACTICAL HINTS AND KINKS

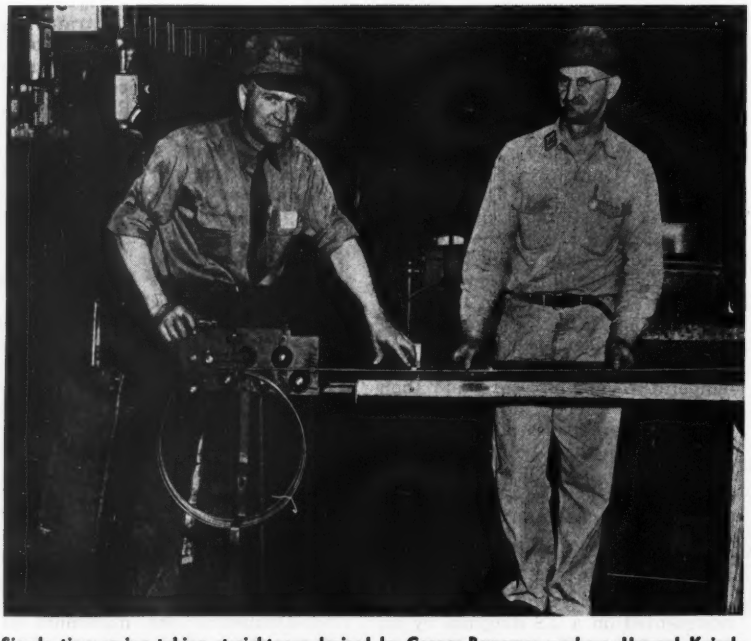
Steel Tubing Straightener

THE ACCOMPANYING illustration shows a device which was made up by two workers, Howard Knisely and Frank Babcock, in the shops of the Cooper-Bessemer Corp., at Mount Vernon, Ohio, for the purpose of straightening steel tubing.

This tubing, of ¼ and 5/16-in. diam, is received in large coils and, previously had to be unwound as needed, straightened with a paddle, then bent and formed to fit a specific connection. With the new device shown in the photograph, the coil is simply positioned over a bracket at the side of the contrivance, the loose end is threaded through the rollers and the tubing is straightened by pulling it out along a horizontal tray where it is measured and cut off to the required length.

With nearly a mile of such tubing used monthly in the assembling of Cooper-Bessemer Diesel engines, the great saving in time and effort through the use of this machine is obvious.

It was made of a few odds and ends of metal and a series of five small rollers.



Simple time-saving tubing straightener devised by Cooper-Bessemer workers, Howard Knisely (left) and Frank Babcock (right)

Ventilating Boiler Drums

By H. McKenna

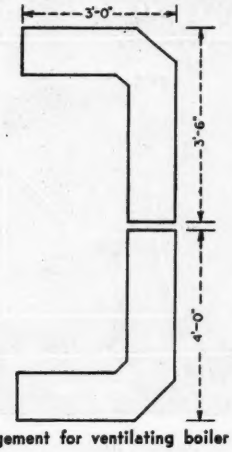
IF YOU EVER worked in the upper drums of one of a pair of dual setting water tube boilers, with the fire on the other side of the party wall going hell bent for leather, you'll be quite willing to admit that the temperature does much to promote the idea that you, as well as the fire, are hell bent.

And whatever doubts remain are soon dissipated by the additional discomfort of the dust, if the job is turbining, or by the fumes, if Apexior type treatment is being applied to the hot metal.

Air circulation can be induced by electric fans, but in that case the workman is exposed to a concentrated air current which, in his heated condition is not so good. And of course the bathtub-electric apparatus-method of exit from this more or less sweet life is always just around the corner when using electric equipment in the vicinity of the boiler, grounded as it is, (like the bathtub) through the water main.

The simple device described here may or may not be new, I don't know. But it sure is the answer to the maiden's prayer, if by now maidens are scaling boilers.

It is made up of 8-in. or 10-in. stovepipe in two sections, which telescope together. One end is inserted in the manhole of the lower drum and the other in the most convenient explosion door aperture, the surplus opening at both



Arrangement for ventilating boiler drums

ends being blocked off with the end of an old pasteboard carton cut to fit around the stovepipe.

The manhole plates are then inserted in the two upper drums not being worked on.

At this stage of the game it will be found that air, in excess of quite a few oodles, is entering the open upper drum, traveling down the tubes to the mud-drum, through the stovepipe to the smokestack via the explosion door, in intimate association with *all* the dust and/or fumes generated by the guy or maiden, as the case may be, in the boiler.

Should he or she, howl about the cold, and believe it or not, that is what happened in our case, even in the front drum, the cyclone can be tamed to a summer zephyr by proper manipulation of the smokestack damper.

A rigid vent pipe would work just as well, the advantage of the telescope being that it gives you a choice of positions which would be needed if you wished to vent the mud-drum through suction from one overhead.

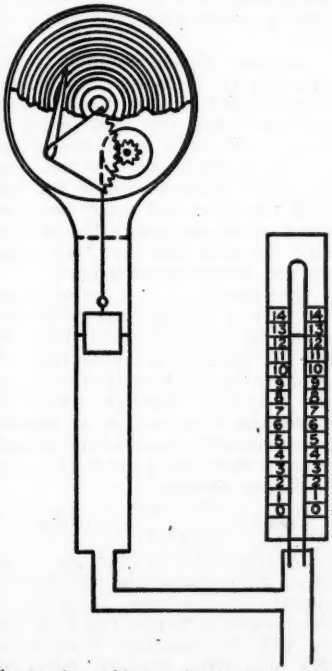
The dimensions given here were found suitable for a 100 hp Stirling boiler. The female half of the telescope is made up. For the rest standard stovepipe and elbows are O.K.

Making Water Gage From Old Steam Gage

To MEASURE the amount of water from a 12 million gal per day centrifugal pump discharging over a weir, there was installed a water gage glass mounted on a gage board. The board was graduated for each million gallons going over the weir at any particular time but there was no means of obtaining a continuous record of the rate of flow.

I gave the engineer in charge, Guy Turrell, an old Bristol steam pressure recording gage and a few hints about making a recording water gage out of it.

The accompanying sketch shows how this was done. A float chamber was made from a 4 in. boiler tube and fitted to an outlet from a gage glass. The



Showing how old recording steam pressure gage was converted to record water flow

working parts of the Bristol gage were changed as shown. A drum and pinion gear was mounted so that a wire could be run over the drum and attached to a float in the float chamber below. The gear meshes with a quadrant to which the pen arm is secured and which has a fulcrum located so that one million gallons on a ¼ in. movement corresponds to one inch on the gage board.

CHRISTIAN BERTELSEN
Engineer in Charge of Repairs
Dept. of Water Supply
Brooklyn, N. Y.

Mercury Contactor Speeds Coil Testing

A MERCURY CONTACTING device suggested by R. L. Bainbridge, a foreman at a General Electric plant, facilitates the testing of random-wound coils before they are assembled in small motors.

With the equipment formerly used, it was necessary to heat the wire in a gas flame and wipe while warm with alcohol to remove the insulation. The wires were then placed on two copper contacts and the necessary electrical test made.

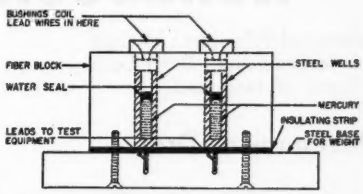


Fig. 1. Details of mercury contactor for testing coils

The new device originated by Mr. Bainbridge makes removing insulation unnecessary. The ends of the wires are placed in mercury pools and contact is made through the bare cross-sectional area at the end. A small amount of mercury is placed in a steel well with an opening and bushing of about one-sixteenth-inch diameter for the coil wires. The steel well is connected to the test equipment. The level of the mercury is maintained below the bottom of the bushing thus preventing it from spilling

Fig. 2. Showing mercury contact coil tester in use

out of the well. A safety seal of ¼-in. of water is maintained on top of the mercury. It is seldom, if ever, necessary to clean or replace the mercury.

The mercury contractor has made the test more positive and safer and has cut the time required for testing 50 per cent.

"That's what we get for hiring a woman!"

The Boiler Fireman's Handbook

BY J. R. DARNELL

Draft—What it means. Fundamental Principles. Weight of Air and Flue Gases. Draft in Chimneys. Draft Loss. Forced and Induced Draft. Types of fans used.

IX Natural and Mechanical Draft

EVERY BOILER FIREMAN should know the various means of producing draft, methods of control and how draft is measured.

There are two meanings to the word "draft." One definition is the flow of air or gases. Such draft is produced by either natural or mechanical means. A second meaning of draft is pressure, usually expressed in inches of water or fractions of an inch less than that of atmospheric pressure. This is sometimes called negative pressure. If the pressure is greater than that of the atmosphere it is spoken of as positive pressure. As an example of the first meaning as expressing a flow of air, one might say: "I feel a draft in here" or "I think I caught cold sleeping in a draft." The boiler fireman refers to the second meaning when he says to a fellow operator: "How much draft do you carry over the fire?" or "What's the draft in the uptake?"

Careful observation of draft pressure conditions in a boiler furnace is as important as knowledge of CO_2 and temperature conditions. Close regulation of draft even without any means of determining CO_2 and temperature will result in good combustion conditions in most instances and such regulation is necessary whether the air for combustion is obtained by natural or mechanical means.

Natural Draft

Natural or thermal draft is always produced by some form of chimney or stack. The flow of air and gases through a natural draft system is produced by the difference in weight between the hot gasses inside the chimney and a column of cold air of equal height outside the chimney. A great many people do not realize that air has measurable weight. There is a huge mass of air completely enveloping the earth up to a height of some 50 miles. At sea level this air presses down on all surfaces with a force of almost 15 lbs per sq in. For example, let us assume a board, 12 in. square. Since it has a plane surface of 144 sq in. the air pressure on this surface is more than 2100 lb. With such pressure how is it possible that we can lift such a board with one hand? The reason is that the air pressure is equal on all sides of the board. However, if we were to place this board on top of a large pipe and exhaust the air from the inside of the pipe, then the air pressure on the upper surface of the board would approach the figure of 2100 lb if we could obtain almost a perfect vacuum inside of the pipe.

Another classic example of the effect of air pressure is to invert a glass full of water in a basin of water and then while the open end of the glass is still under water firmly press a piece of paper over the end. Keep the paper pressed against the glass until the glass and paper have been lifted out of the basin. The air pressure will then hold the paper against the end of the inverted glass.

Referring to Fig. 1, let us assume we have a stoker fired boiler connected to a chimney 200 ft high. The flue gas inside is at an average temperature of 550 F while the air outside is at 65 F. Since the weight of a cubic foot of air or gas is inversely proportional to its absolute temperature we find that a cubic foot of air at 65 deg weighs:

$$0.0807 \times \frac{32 + 460^*}{65 + 460} = 0.0756 \text{ lb}$$

A cubic foot of flue gas at any given temperature and CO_2 value is slightly heavier than air as may be determined by Tables I to V in Chapter VII. For example, if we assume flue gas from Eastern bituminous coal with 14 per cent CO_2, as shown in Table II, we find that one cubic foot of this gas at 65 deg weighs 0.0784 lb. At 550 F this gas weighs:

$$0.0784 \times \frac{65 + 460}{550 + 460} = 0.0451 \text{ lb}$$

Since we have assumed a chimney 200 ft high as shown at 1 in Fig. 1 and a column of air of equal height designated as 2 as shown by the dotted lines, the difference between the weights of one cubic foot of air at 65 deg and flue gas at 550 deg is 0.0756 —0.0451 = 0.0305 lb for each foot of height. For a chimney 200 ft high and at sea level, the pressure per square foot at the base of this chimney would be 0.0305 x 200 = 6.1 lb.

Since a cubic foot of water at 65 F weighs 62.33 lb, a water column

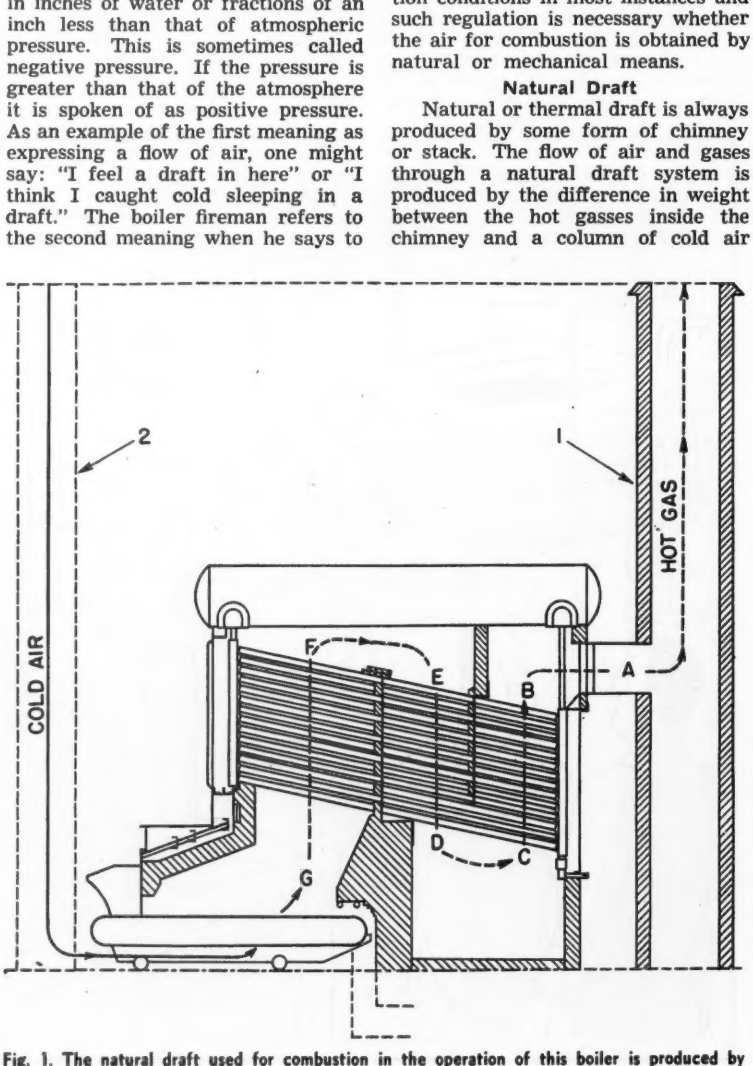


Fig. 1. The natural draft used for combustion in the operation of this boiler is produced by the difference in weight between a column (2) of cold air equal in height to the 200 ft chimney (1)

*The figure of 460 is used on the Fahrenheit scale to indicate the temperature below zero at which all molecular motions ceases. It is the lowest temperature at which any matter can exist and is called absolute temperature.

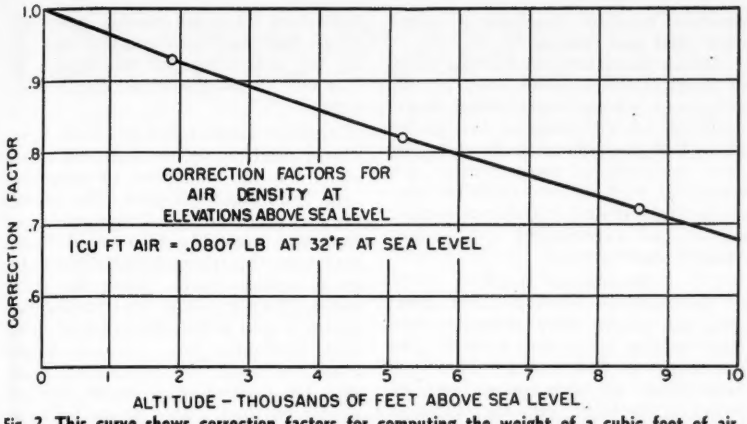


Fig. 2. This curve shows correction factors for computing the weight of a cubic foot of air at any altitude between sea level and 10,000 ft

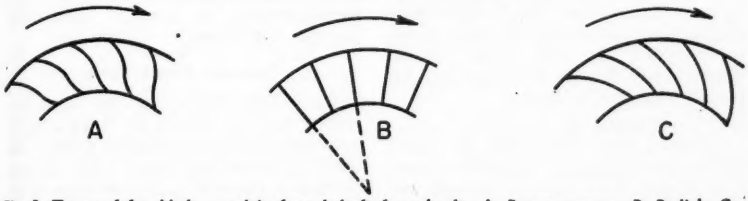


Fig. 3. Types of fan blades used in forced draft fan wheels. A, Reverse curve. B, Radial. C, Backward curve

1 in. high would produce a pressure of $\frac{62.33}{12} = 5.194$ lb per sq ft. The draft pressure, therefore, which a chimney 200 ft high would produce at an average temperature of 550 F, would be $\frac{6.1}{5.194} = -1.17$ in of water if frictional losses are disregarded. The draft for any given chimney height can be figured in like manner.

Figure 2 is a curve of correction factors for air densities at different elevations above sea level. For example, if we were to assume the foregoing conditions for a chimney 200 ft high but at an elevation of 3000 feet above sea level, the draft at the base of the chimney would be 1.17 x 0.891 = —1.04 in. It should be noted that the higher the elevation the lower the draft pressure becomes for any given temperature. This is true because the weight of a cubic foot of air or gas becomes less and less as the elevation above sea level increases. A cubic foot of air at 65 F weighs 0.0756 lb at sea level but at the same temperature at an altitude of 10,000 feet, it weighs only 0.0515 lb. Since its density is less, that is, since it isn't so heavy it can't support a column of water of the same height as the heavier air at sea level. At 10,000 feet, with the same conditions as previously given for 3,000 feet, our chimney 200 ft high will produce a draft of only —0.8 in.

Draft Loss

Draft loss means the resistance to flow of either air or gas. With natural draft the chimney must do all of the work whereas with forced or induced draft or a combination of both, one or two fans do some or all of the work of the chimney. Fans of these types will be discussed later under the heading of Mechanical Draft.

In any draft system whether it is natural or mechanical there are certain definite items of draft loss, the sum of which must equal the total draft pressure which the draft system is able to produce. Referring to Fig. 1 we see that as the air in our column 2 pushes into the furnace through the stoker grate and fuel bed and then through the various passes

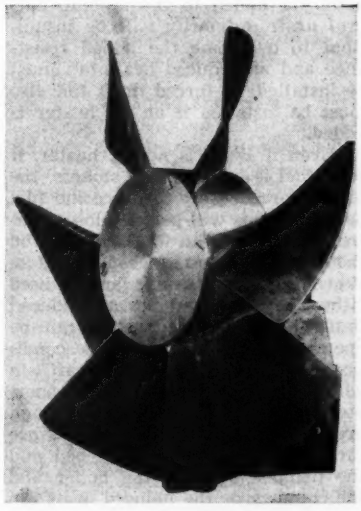


Fig. 5. This is a wheel for a propeller type fan, used for either forced or induced draft

in the tube bank it must first overcome the resistance of the grate and fuel bed, then the resistance of three passes through the tube bank including six right angle turns before passing upward through the chimney. These are the resistances commonly found in a natural draft system when firing solid fuel. With oil or gas firing, since there is no fuel bed resistance to be overcome, the damper in

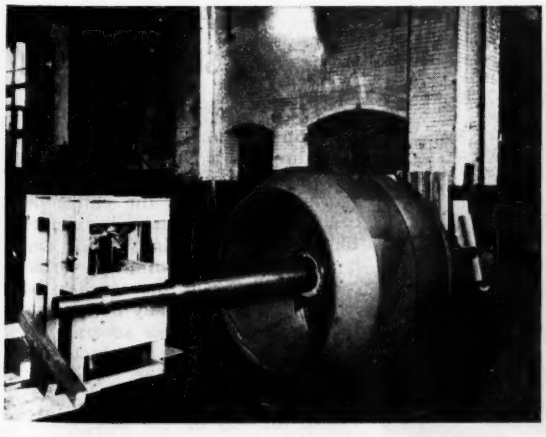


Fig. 4. Complete wheel assembly with blades of the backward curve type as shown at C in Fig. 3

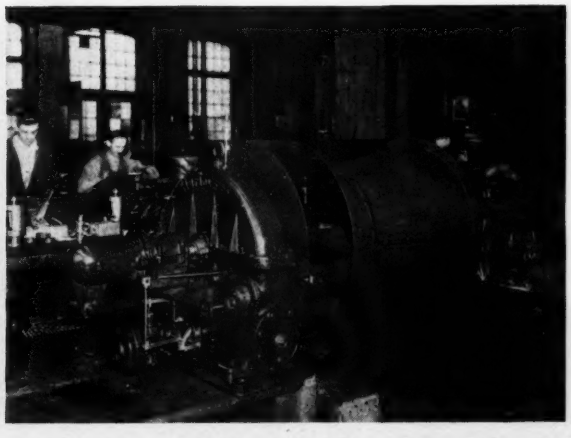


Fig. 6. This is a complete assembly of the propeller type fan wheel of Fig. 5, mounted directly on a turbine shaft. Note the air inlet guide vanes around the periphery of the wheel

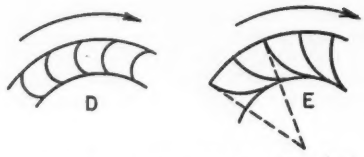


Fig. 7. Types of blades used in induced draft fan wheels. D, Forward curve. E, Radial at tip, forward curve at base

the uptake can be adjusted more nearly to a closed position if the air is allowed to flow freely around the burners into the furnace with the least amount of resistance.

If an economizer of air heater or both, are added to the system, natural draft ordinarily will be insufficient to overcome the added resistance and an induced draft fan must be installed. A forced draft fan also must be installed if an air heater is added.

Even if there is no air heater, if solid fuel is burned with stokers, the use of forced draft to overcome fuel bed resistance will permit closer control of the draft in the furnace even though there be no induced draft fan. When a forced draft fan is used either with or without an induced draft fan, the draft system can be operated so as to produce the condition known as "Balanced Draft" in which the forced draft fan is operated so as to produce just enough pressure to overcome the resistance through the grate and fuel bed and the damper between the boiler and the chimney or the induced draft fan is regulated in such manner that there is just enough draft to draw off the furnace gas and at the same time permit the draft in the furnace just above the fire to be maintained at approximately atmospheric pressure, say about —0.01 or —0.02 in. water gauge pressure. This is impossible with natural draft since a greater pressure must be available to overcome fuel bed resistance.

Before discussing the various kinds of draft troubles which may be encountered and methods of draft measurement we will describe briefly the subject of mechanical draft since the same methods of measurement are employed with either natural or mechanical draft and troubles of similar nature are experienced with either kind of draft system.

Mechanical Draft

Installations with forced draft only are much more common than those having both types of fans. Occasionally we find a plant, oil or gas fired, with an economizer installed between the boiler and the chimney. The added draft resistance of the economizer increases the total draft to such figure that the height of a chimney for natural draft only would be excessive. In such a case an induced draft fan is installed but no forced draft fan is needed.

Forced Draft Fans

Forced draft fans may be either of the centrifugal or propeller type. Centrifugal fans are so named because the rotation of the wheel causes air or gas to flow outwardly off the ends or tips of the blades by centrifugal action. Figure 3 illustrates three common types of blades found in centrifugal forced draft fans, in which the blades marked A are those of the reverse curve type, B is the steel plate or straight radial type and C has blades with backward curve. Figure 4 shows a complete wheel assembly of the latter type. Fans with blades of this type are the most efficient and since they have smaller wheels and operate at higher speeds for the same pressure conditions as compared to the other types, they are better adapted to direct connection to electric motors or steam turbines. Operators must be careful, however, to see that no grease and dirt collects on the under side of the blades as this will throw the wheel out of balance.

Another type of fan which is commonly used for forced draft on small stokers is the axial flow or propeller type fan. Figure 5 shows the wheel for this type and Fig. 6 illustrates the complete assembly of one of these fans with the wheel directly mounted on a turbine shaft. Note the inlet vanes which give the air entering the wheel a spin in the direction of flow, thus lessening the entrance shock and improving the efficiency. Note also the expanding or evasé type of discharge duct. This propeller type fan with alloy steel construction has been used for induced draft at high temperatures on certain industrial process operations.

Induced Draft Fans

Fans with blades of the straight radial type as shown at B in Fig. 3 are also used for induced draft. In addition there are those with blades having a forward curve as shown at D in Fig. 7. The blades shown at E in Fig. 7 have a forward curve at the base and are radial at the tip. Figure 8 shows a large wheel of this type, built to operate at high speed. With induced draft a high chimney is not necessary. As a rule, a short stub stack on top of the building is all that is necessary.

Steam Jets

The use of steam jets of the type installed in the base of the stack on a locomotive may be considered as a form of induced draft. Such application, however, is costly, inefficient and should not be encouraged in stationary boiler practice.

In the next installment consideration will be given to the subject of draft gages, where and how to measure draft and the troubles that may be encountered in the operation of draft systems.

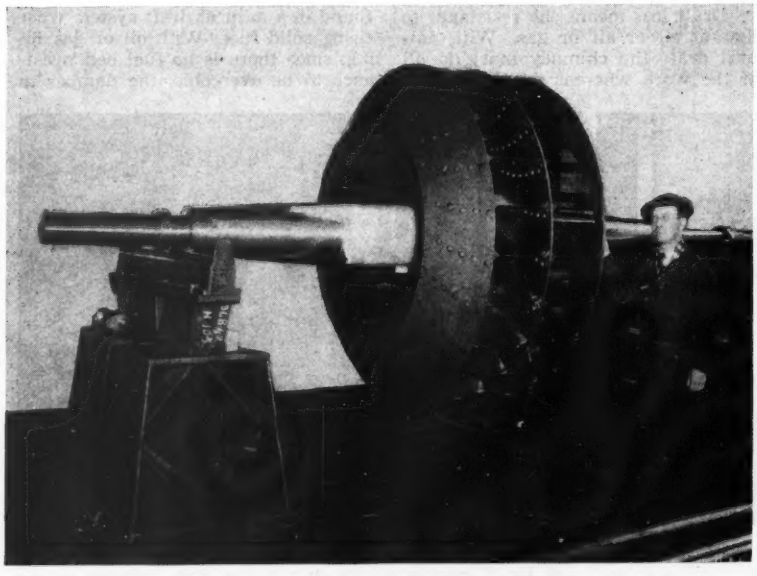


Fig. 8. Complete assembly with blades of the radial tip type as shown at E in Fig. 7

Repairing Short-Circuited Field Coils

Field coils used on synchronous and direct current machinery can sometimes be corrected for internal shorts by removing the entire field coil and heating it to approximately 100 C; dipping it in varnish while hot, allowing it to cool in the vernish; removing it from the varnish, and baking it again. It may be necessary to repeat this process several times in order to obtain a satisfactory repair job.

If, however, the field winding is wound directly on the pole, the coil should be left assembled on the pole, and both the coil and the pole treated as one unit.

FOR THE PLANT ELECTRICIAN

How to Maintain Lighting*

THE IMPORTANCE of good light in industrial plants has a direct bearing on the quality and speed of work. Important, too, is the fact that good lighting has a great influence on employee morale. Plants that have a regular time to check up and clean lighting equipment find this practice is an indispensable part of their plant operation.

With proper maintenance, the average plant can obtain at least one third more light than with conventional maintenance methods, and without any additional purchases of critical materials, power, or lamps.

It has been estimated that one man, working continuously, can clean and relamp fluorescent reflectors that provide light for approximately 360 workmen. If the increased light which the maintenance man provides, through cleaning and relamping, increases the personal effectiveness of these 360 men only 0.28 per cent, the maintenance man's time has been accounted for.

Lighting maintenance consists of replacing lamps, cleaning lamps and reflectors, and maintaining proper voltage conditions. When the cost of maintenance is properly considered in relation to the cost of the entire installation, it will be found that frequent cleaning of reflectors is the most economical method of obtaining higher-than-average light output.

Should Lamps Be Group Replaced?

Group replacement of lamps in a lighting system often can be justified by a reduction in the labor cost of replacement. This method of lamp replacement requires that the original group of lamps be left intact until 80 per cent of their average life has been reached. By this time, 20 per cent of the original group will have failed, and the balance will have delivered 83 per cent of all the light they can deliver. At this point it is often less expensive to replace the entire group and discard all the lamps because the value of the useful light remaining in any lamp is that less than the cost of replacing the lamp individually. There are, however, some circumstances where group replacement may not be practical.

FLUORESCENT LAMPS—Fluorescent lamps offer the best opportunity for group replacement. Since a large number of lamps usually provide the illumination at any given location, individual outages do not seriously affect the light in adjacent areas. The lamps that have failed can wait for replacement until the time of the next group-replacement period.

FILAMENT LAMPS — If, in a large area, all of the lamps are operating at essentially the same voltage for the same length of time, group replacements may be practical because lamp life will be reasonably uniform. However, when the light output per lamp is high, an outage may leave the nearby floor area relatively dark. In cases of this kind, group replacement is not practical.

MERCURY LAMPS — Group replacement of mercury lamps is impractical in most cases because of the high output per lamp, as well as the high unit cost. In addition, it is not easy to determine the lamp life.

Preventing Overloads on Wiring Systems

Today many plants are faced with the problem of creating "production lighting" levels of 20, 30, or 50 ft-candles for three-shift operation with a wiring system designed for only one or two watts per square foot. Where filament lamps are retained, in some cases the panelboard voltage has been doubled and 115-volt lamps operated two in series. This essentially doubles the illumination that can be obtained from a given wiring installation.

Where fluorescent or mercury lamps are replacing filament lamps, the voltage can also be doubled, using 236-volt ballasts or transformers. But the resulting illumination will be quadrupled, since the fluorescent or mercury lamps are twice as efficient as the filament lamps. In this way, reasonably modern lighting levels can be had without necessarily rewiring the plant.

Cleaning Materials

Many cleaners and detergents are suitable for cleaning lighting equipment. In general, since porcelain enameled, mirrored glass and prismatic glass reflectors all have glass surfaces, the strength of the cleaner in most cases will not harm the surface; for example, alkaline compounds are frequently used. However, care must be taken in cleaning aluminum reflectors, since an alkali will tend to attack the metal. Neutral detergents or special wax or wax-emulsion cleaners which have been developed specifically for cleaning aluminum are recommended.

It is suggested that the plant engineer consult representatives of companies which manufacture industrial cleaners. Such representatives are well acquainted with the various types of dirt found in plant interiors and the specific cleaners which will be most satisfactory.

Tungsten-Filament (Mazda C) Lamps

Tungsten-filament lamps are designed to produce the greatest amount of light for the lowest cost (at average industrial-power rates) when operated at the voltages for which they are designed. Operating lamps at higher voltages than those for which they are designed, will result in increased lamp efficiency, but with

* Abstracted from How to Maintain Electric Equipment, published by the General Electric Co.

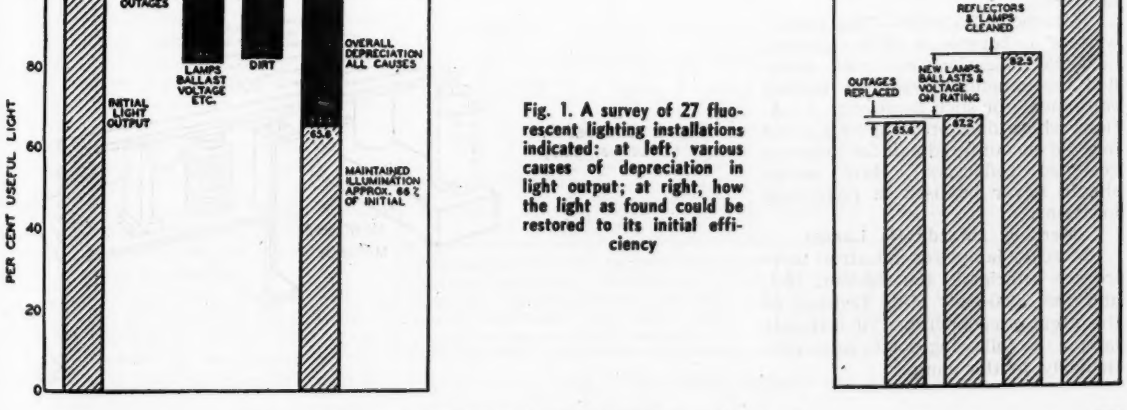


Fig. 1. A survey of 27 fluorescent lighting installations indicated: at left, various causes of depreciation in light output; at right, how the light as found could be restored to its initial efficiency

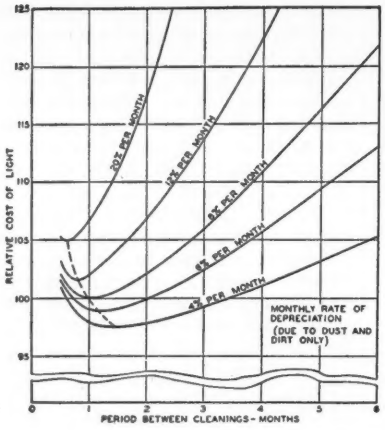

RELATIVE COST OF LIGHT
PERIOD BETWEEN CLEANINGS - MONTHS
20% PER MONTH
12% PER MONTH
8% PER MONTH
6% PER MONTH
4% PER MONTH
MONTHLY RATE OF DEPRECIATION (DUE TO DUST AND DIRT ONLY)

Fig. 2. With the aid of this chart, it is possible to determine the most economical period between cleanings. Since the collection of dirt varies, the dotted line shows when the reflector should be cleaned in relation to dirt accumulation. (Based upon a cost of 10 cents per cleaning.)

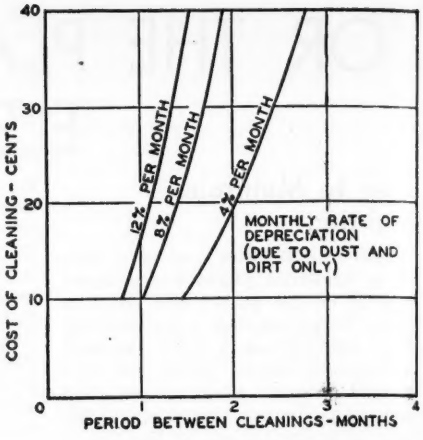

COST OF CLEANING - CENTS
PERIOD BETWEEN CLEANINGS - MONTHS
12% PER MONTH
8% PER MONTH
4% PER MONTH
MONTHLY RATE OF DEPRECIATION (DUE TO DUST AND DIRT ONLY)

Fig. 3. With the aid of a simple chart, it is also possible to determine the most economical periods for cleaning at various costs per cleaning

a sacrifice in length of life—which increases the lamp-replacement problem. Undervoltage operation increases life, but sacrifices lamp efficiency—which results in an increased cost of light. A 5 per cent decrease in voltage results in approximately 16 per cent loss of light. Poor lighting can often be traced to gradual load increases that have decreased socket voltages.

TEMPERATURE — Normal ambient temperatures have relatively little effect on filament-lamp efficiency. However, under extreme conditions of improper usage, certain difficulties may be encountered. These are: bulb blistering, loosening of the base, deterioration of the socket parts, and thermal cracks due to localized cooling when fixture parts are allowed to touch or hang on lamps. Occasionally violent failures of lamps occur because of thermal cracks. Such conditions are more often encountered with specialized lighting equipment for hazardous locations, spot lighting, floodlighting, and radiant-energy heating than with equipment for general lighting.

WATER STRIKING BULB—Premature failures of general lamps for lighting (soft glass) often occur if they are located where rain, snow, or bugs can strike them. Such lamps should be protected by screens or glass cover plates. The use of hard-glass lamps, such as the 150-watt PAR-38 projector, spot, or floodlight lamps, will usually eliminate such failures.

HAZARDOUS LOCATION—The Underwriters' Laboratories have classified hazardous locations and have specified recommended types of lighting equipment for such locations. Locations where dust or dangerous gases may be encountered call for properly designed reflectors. Bare lamps should never be used in hazardous locations.

Mercury (Mazda H) Lamps

Mercury lamps for industrial service are principally the 400-watt H-1, and the 3000-watt H-9. Because of the great preponderance of 400-watt lamps, the following points refer particularly to this lamp:

VOLTAGE—The light output of mercury lamps varies with voltage in approximately the same ratio as tungsten-filament lamps. Mercury-lamp transformers for the 400-watt lamp are equipped with four taps which permit proper adjustment to various line voltages. However, it is highly desirable that the line voltage vary less than 5 per cent plus or minus from the tap setting. It is desirable because of other features of mercury-lamp performance besides life. There is no definite relation between the life of a mercury lamp and the operating voltage or light output, as is the case with filament lamps. However, unsatisfactory performance may result if the transformer tap setting is not within 5 per cent of the outlet voltage.

Voltage dips of more than 10 per cent often cause the lamps to drop out of the circuit. However, if the leading lamp is operated by a Tulamp transformer, operating two lamps out of phase from a single-phase source, it can withstand a greater voltage drop than the lagging lamp, or a lamp which is operated from a single-lamp transformer.

Staggering the Operation of Electric Welders

AS INDICATED in our analysis of Problem 38 in the preceding issue, many of the solutions submitted besides those that were awarded prizes, were worthy of comment. Since space was lacking in the March issue, the discussion of the solutions is continued here.

Among the solutions that were "different" the one by Charles F. Lehr almost competes with Roland Berti's scheme of tying relays together by means of a string. Instead of string, Mr. Lehr uses a trough of mercury. A diagram of his relay, which he calls a "subway" relay is shown in Fig. 1. "After considering a variety of inverse time, thermal, and other kinds of relays," writes Mr. Lehr, "stumbled upon a mechanical device which I prefer to call a 'subway' relay because of its resemblence to a subway car during the rush hours.

"As shown, the device consists of 12 relay coil magnets mounted in a single row, fitted with an armature arm to which is attached one pair of contacts and a displacement plunger. The contacts will close a circuit when the coil is energized providing there is displaceable space for the displacement plunger.

"Each plunger is inserted in a cylinder and 12 of these cylinders are mounted in a row with their bottoms entering a closed reservoir so that cylinders and reservoir form a mani-

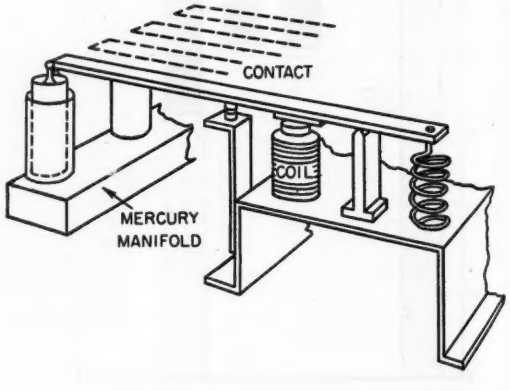


Fig. 1. Charles F. Lehr's "subway" relay

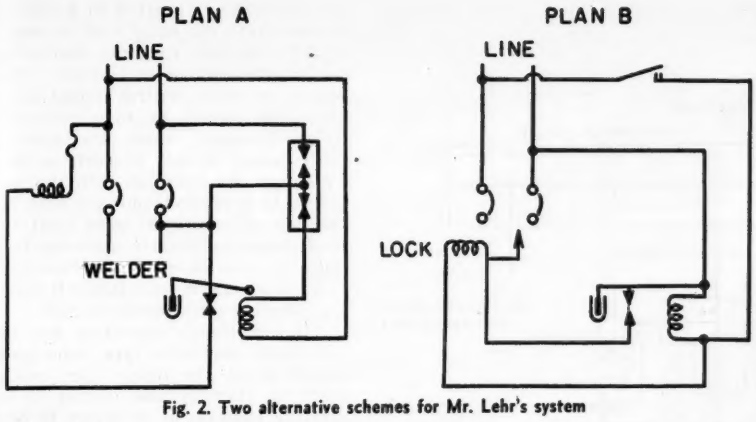


Fig. 2. Two alternative schemes for Mr. Lehr's system

fold slightly resembling a pipe organ. These cylinders would not be necessary if a frictionless and leak-proof packing was obtainable, but because of this lack, resorting to a hydrostatic seal does the job very nicely.

"It is important that each plunger have the same displacement when the relay is 'closed' to insure trouble free operation, but little or no difficulty is encountered if adjustment is made on each plunger when seven other relays are closed and with a reference height set.

"It is possible to readily vary the number of welding machines that can be operated at once from one to eleven with only changing the amount of mercury which becomes 'undisplaceable' media once the air space is filled with displacement plungers.

"Not knowing too much about the type of 'Individual circuit breaker equipped with an overload trip' that our hero speaks of, I prefer to mention two methods of connecting the 'Subway Relay' so that if an electrically operated or hand operated breaker is in use, either may be used with a minimum of alterations.

"Plan A (Fig. 2) calling for an energized holding coil would utilize a start button wired to the line side of the breaker and a stopping circuit wired in the load side to hold the relay 'in.' The contacts on the relay would in turn pull the breaker in or kick it out.

"Plan B (Fig. 2) would make use of nothing more than a small selonoid or electro-magnet attached to a mechanical lock on the breaker which would drop into place in the breaker latch rendering the breaker inoperative unless the selonoid was energized. A knife switch could be used to close the subway relay if less than eight machines were operating or remain ready to close if more. The selonoid would remove the lock and permit operation of the machine, although when finished the switch would have to be pulled out to 'clear' for another machine.

"It is important to note that a very loose fit is used in the cylinders as the relay is prevented from operating because of the power of the mercury to float the plunger (a force equal to the weight of mercury displaced.) For our heros' benefit I would suggest a light fuse be placed in control circuits for protection."

Four Schemes by R. E. Buffington

R. E. Buffington of Philadelphia submitted four different schemes. As he put it in his letter, the one which may be considered best will depend upon how near "fool proof" the system has to be and also upon what kind of material is available. Mr. Buffington's four schemes are shown in Fig. 3.

SCHEME No. 1. This requires a sensitive relay. Although the diagram shows a plunger type relay, in reality it is an ammeter with contacts which can be set so that they will close at a given load. It must be calibrated with the shunt shown in the diagram. The upper contacts would be set to close at a little less than the 400 kw rating of the generator, and the lower contacts set at about 350 kw. At each welding machine there will be required three lights—red, green and white—and a push button. It is recommended that these lights be of the size often used in radio work, and on switchboards, ¼ amp, 6 v, this voltage being obtained from the lighting circuit through a small transformer. These lamps are not colored, but are placed in sockets of colored glass lenses.

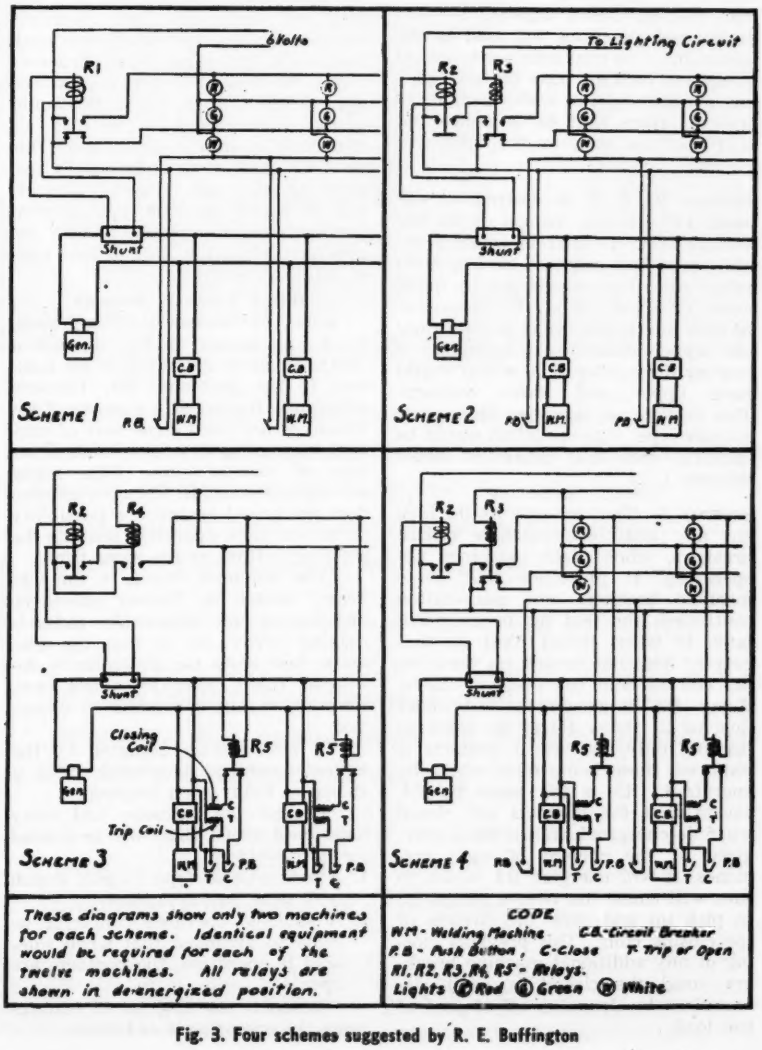


Fig. 3. Four schemes suggested by R. E. Buffington

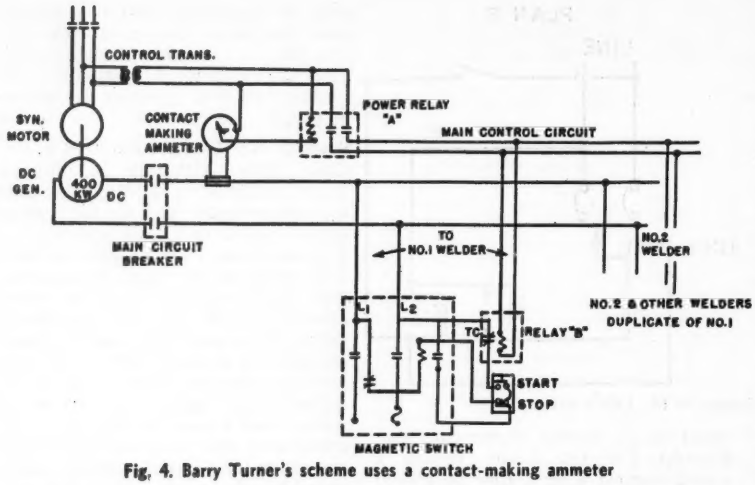


Fig. 4. Barry Turner's scheme uses a contact-making ammeter

The operation is, that if less than 8 welding machines are operating, the contacts of relay R1 will be closed, as shown, and the green lamps will light up, indicating that an additional machine may be started. If 8 machines are operating, the upper contact will be closed, lighting the red lamps and indicating full load on the generator. The next man ready would press and hold his push button, lighting a white light at each machine, to inform others that he is ready and will start as soon as the load will permit.

SCHEME 2. If it is desired to use small 110 v lamps, instead of the low voltage ones, the current would probably burn the contacts on the main relay, since they would not be quick make or break. Relay R2 is similar in type to R1, but needs to have only one upper contact. It energizes a heavier duty relay R 3, which would have upper and lower contacts. This relay may be either plunger or clapper type. The operation would be identical with that described under Scheme 1.

SCHEME 3. This scheme would lock out any additional machine circuit breakers, when eight machines are operating. It presumes that these machine breakers are push-button controlled, and that the breaker will latch in when closed—that is, that current does not remain on the closing coil to hold the breaker closed. Relay R2 is as described under Scheme 2. Relay R4 is the same as R3, but only one set of contacts is required, these being open when de-energized. R5 is the same as R4, except that the contacts are closed when de-energized. When R2 is energized by the current of eight machines, it will energize R4, which in turn will cause the twelve relays R5 to pick up and open the circuits of the closing coils. This prevents closing of any additional machine breakers, until the circuit is again de-energized by dropping off of part of the load.

SCHEME 4. This is a combination of the indicating lights of Scheme 2 and the lockout devices of Scheme 3.

Remarks

Admittedly, none of these schemes will absolutely prevent overloads on the generator. It is possible that two men will have additional machines ready and press their indicating push buttons at the same time (Schemes 1-2-4), or close their breakers at the same instant, when relays R5 would permit (Schemes 3-4). In fact, all four could go into action at once. This does not seem very probable. If two men did start with 7 already operating, it would mean a 12.5 percent overload for two minutes, which the generator should be able to take care of without trouble.

Barry Turner's Solution

Barry M. Turner of Ticonderoga, N. Y., as shown in Fig. 4 used a contact-making ammeter in his solution to the problem. Mr. Turner's solution is typical of a number of solutions which used some sort of current measuring device to control relays of various types. Like many others, however, Mr. Turner's solution does not guard against the possibility of two or more operators pushing the starting buttons at the same time.

"The ammeter shown in the diagram," writes Mr. Turner, should be one having an adjustable contact-making device, set so that the contacts close when the generator is delivering rated capacity; in this case, when there are 8 welders in operation.

"A power relay actuated by the ammeter contacts is needed. This is shown as Relay A on diagram.

"Besides the ammeter and relay mentioned above, there will be needed for each welder:

1. A conventional type magnet switch with push button station.
2. A solenoid operated contactor or relay so arranged that when solenoid is energized, the contacts are open.

"Referring to diagram of connections, the operation is as follows:

"Operation is started in a normal manner until the rated load is reached. The ammeter contacts close when the eighth welder is started. This causes the main control circuit to be energized which in turn energizes Relay B which opens the starting push button circuit of each welder. This does not interfere with the machines in operation, but prevents the starting of additional ones until the load drops sufficiently allowing contacts to open de-energizing the control circuit and in turn Relay B closes the Starting push button circuit.

"If our Hero's operators are the extremely ambitious type, who grow impatient at the delay, they might hold the starting push button in its starting position in an effort to beat the next fellow. If only one did this, there would be no trouble, but should two or more block the starting button in and only one operator finished, the system would overload and, well, our Hero had better go see the recruiting officer and stop worrying about the Draft Board.

"To overcome this possibility, Relay B should be selected from a type having adjustable time delay in closing. By adjusting each relay to a different closing time, the main control circuit could then limit the number of machines working and thus prevent overloading.

"Pilot lights could be installed at each station to indicate to the waiting operators as to when the system is "open" for business.

"All the equipment needed is standard and if magnetic switches are already in use, they would require little or no changing to fit into the control scheme."

Devulcanizer Takes Off Like a Rocket

As reported in the January issue of The Locomotive, the explosion recently of an unfired steam pressure vessel used for the purpose of devulcanizing rubber caused property damage loss estimated at more than $40,000 and seriously affected production at the plant for a long period of time.

The vessel was nearly 7 ft in diameter by 33 ft long and had a capacity of 10,000 lb of scrap rubber at a single charging. Built for a working pressure of 250 psi, there was actually 235 psi within the devulcanizer when the failure occurred. The accident was caused when the door of the vessel blew off because it was improperly fastened. A rocket-like effect followed the escape of steam and the devulcanizer was torn off its foundation and projected rearward more than 50 ft from its original position.

In spite of the violence of the explosion and the property damage, fortunately there were no personal injuries.

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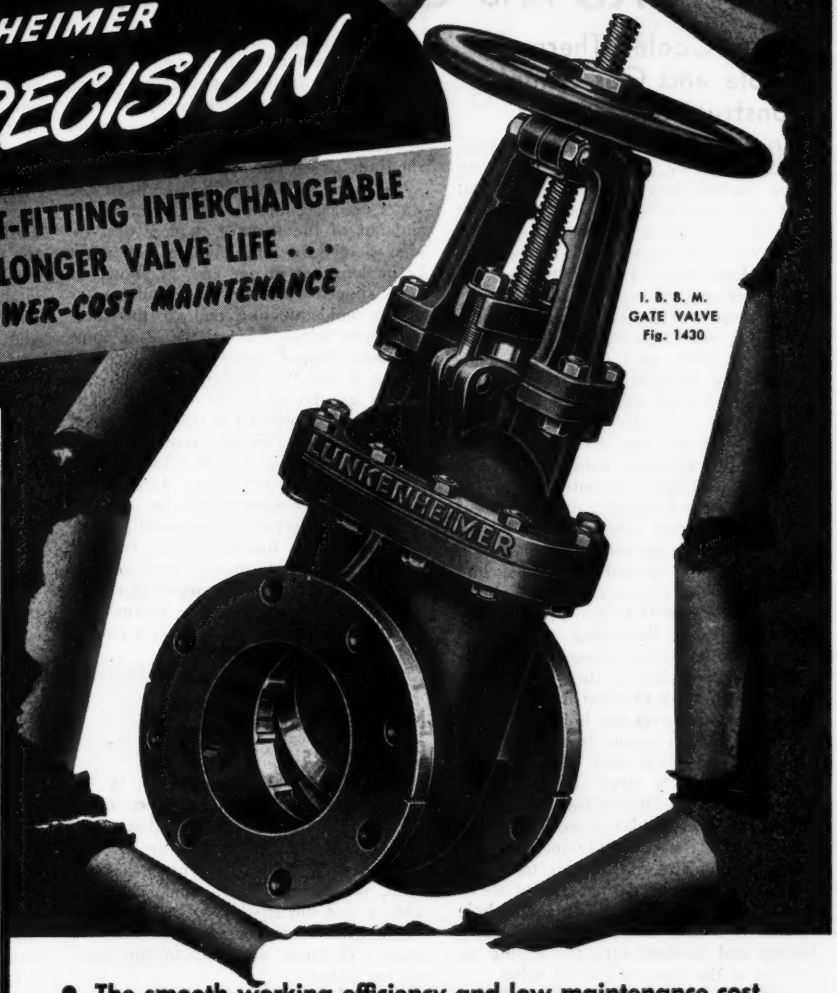
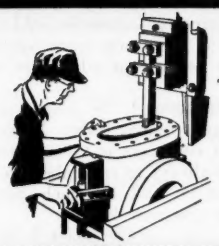
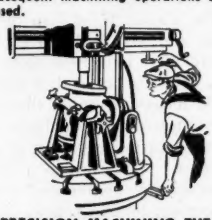


I. B. B. M.
GATE VALVE
Fig. 1430



HE GIVES LUNKENHEIMER VALVES SOMETHING OTHER VALVES HAVEN'T GOT

He machines body guides down to precision tolerances, assuring a perfect guide for the disc and creating a positive center line on which all subsequent machining operations are based.



PRECISION MACHINING THE BODY FOR SEAT RINGS

is precision work to the "nth" degree, for this operation makes inserting the seat rings in a Lunkenheimer gate valve simply a matter of screwing them into position. Parts can be replaced without any machine work or special fitting.

• **The smooth-working efficiency and low maintenance cost of Lunkenheimer Valves were not "made in a day". Behind this superior performance and economy lies long experience, and an ideal of precision which guides every operation from design to final assembly.**

Lunkenheimer Valves have a streamlined simplicity of design . . . a minimum of working parts, each part of extra strength, correctly proportioned and perfectly balanced. This assures longer life with the least trouble and maintenance expense.

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LUNKENHEIMER VALVES

LETTERS AND COMMENTS

Water Cooled Thermocouple and Gas Sampler Construction

IN CHAPTER NO. 5 of the Boiler Fireman's Handbook, in the December, 1944, issue, readers were advised on page 101 that the author, upon request, would furnish directions for constructing a water-cooled thermocouple. Such requests having been received, the following data have been sent in reply to them.

In these war times, a priority certificate may be necessary to obtain brass tubing or even steel tubing, but aside from these difficulties the construction of a water-cooled thermocouple is relatively simple. As shown by the accompanying drawing, any desired length of 1½-in. brass or steel tubing A of 12-14 gage, is selected as the outer casing for the water cooled thermocouple. A circular disc C of brass or steel with a 1½-in. hole at or near its center, similar to a washer, is next brazed or welded into one end of the 1½-in. casing. A somewhat similar disc D is also provided for the other end of the casing.

A piece of ½-in. tubing B the same length as the casing is then brazed into the center hole of the first disc A. Next, disc B provided with two holes as shown, is slipped over a second length of ½-in. tubing E with one end bent at right angles to form a nipple about 2½ in. long as shown. This tubing is then inserted into the annular space in the casing between the center tubing and the casing wall. The end of this tubing E projecting into the casing is kept about 1 in. from the far end. The center hole in disc D is then slipped over the center tubing and breezed into the casing as well as to the inner and outer tubes.

Prior to the assembly and brazing of the tubing, a ½ in. diameter hole must be drilled into the outer casing about 3 in. from the end, as shown at F. A nipple of ½ in. tubing about 2½ in. long is brazed to this opening. This provides the outlet for the water. Conventional rubber and canvas water hose of suitable length is clamped to nipples E and F. It is advisable to have the end of the outlet hose which is clamped to F placed in or near a floor drain or sink where the flow of outlet water can be observed.

Thermocouple wires, strung on porcelain tubing must be tightly packed with asbestos rope in the center tubing. Since this water-cooled couple is to be used for high temperatures, the wire should be either of platinum and platinum-rhodium or chromel-alumel.

In order to balance the weight of the water-cooled couple when moving it in and out of the furnace, a piece of 2-in. pipe, 6 to 8 ft. long, with a slot about 12 in. long cut in one end, as shown at G, is slipped over the water connections of the cold junction end of the thermocouple wires. After the 2-in. pipe has been slipped over the thermocouple casing it can be held in place by set screws as shown in the drawing. The cold junction end of the couple can then be connected to binding posts provided in a fibre or bakelite block which can be attached to the 2-in. pipe. Lead wires can then be connected to the binding posts and connected to the potentiometer.

It may be of interest to note that the water-cooled casing may be used also for taking samples of high temperature furnace gases by removing the thermocouple wire assembly and inserting a rubber stopper and glass tubing.

Naperville, Ill. J. R. DARNELL

More About Chief Engineers

I WOULD like to comment on W. T. M's letter on incompetent engineers in the November issue. I agree that many but not all chief engineers are of the "know-it-all" type. Just now, at our plant, we have a chief who, to begin with, is not old enough to know all the answers, and judging from his attitude, never will know much about the engineering game.

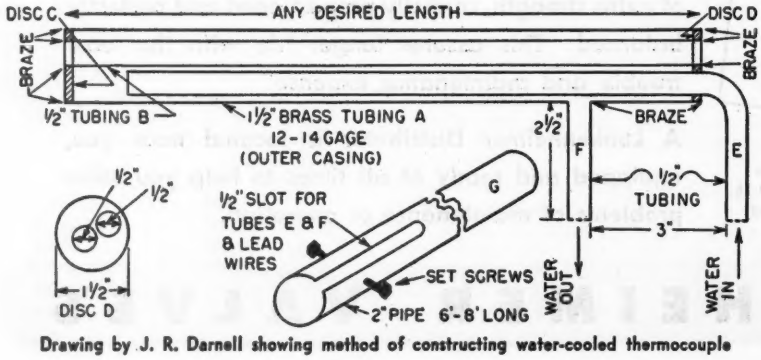
My old chief on shipboard taught me always to be ready and willing to listen to the other fellow as he may have something to say that can prove valuable. Since the last war, I have worked in a laundry, in a textile plant, also operated 12 ferryboats both side wheel and twin screw. In short, I have been able to accumulate a lot of knowledge in these 20 odd years, but I still have much to learn. In view of my own experience, I fail to see how any chief engineer can strut around, trying to make one believe that he has all the knowledge in that little brain of his. I will wager if most chief engineers were put to a real test regarding their knowledge of the field, they would be found wanting. I know I would. Awhile back, I talked to a chief engineer on a subject relating to a feed-water heater that had the water leg removed. I told him that in my opinion this leg should never have been removed as it was installed to take care of 3 lb pressure during the heating season. Believe it or not, a silly discussion followed which showed the utter lack of knowledge of this man.

Most of my experience with chief engineers has been pleasant. The marine engineer as a rule is a regular fellow and is always eager for knowledge. To any chief engineer who reads these words let me say that it pays to listen to the other fellow even though you may not agree regarding the subject being discussed. You may learn something which may be to your advantage in the future.

It is far better to be devoid of ego than to have to save face. My advice to all chief engineers is to be a regular fellow and always to remember the days when someone had to teach you the things that you now know.

SAM J. AYLING
Marine Chief

Philadelphia, Pa.



Drawing by J. R. Darnell showing method of constructing water-cooled thermocouple

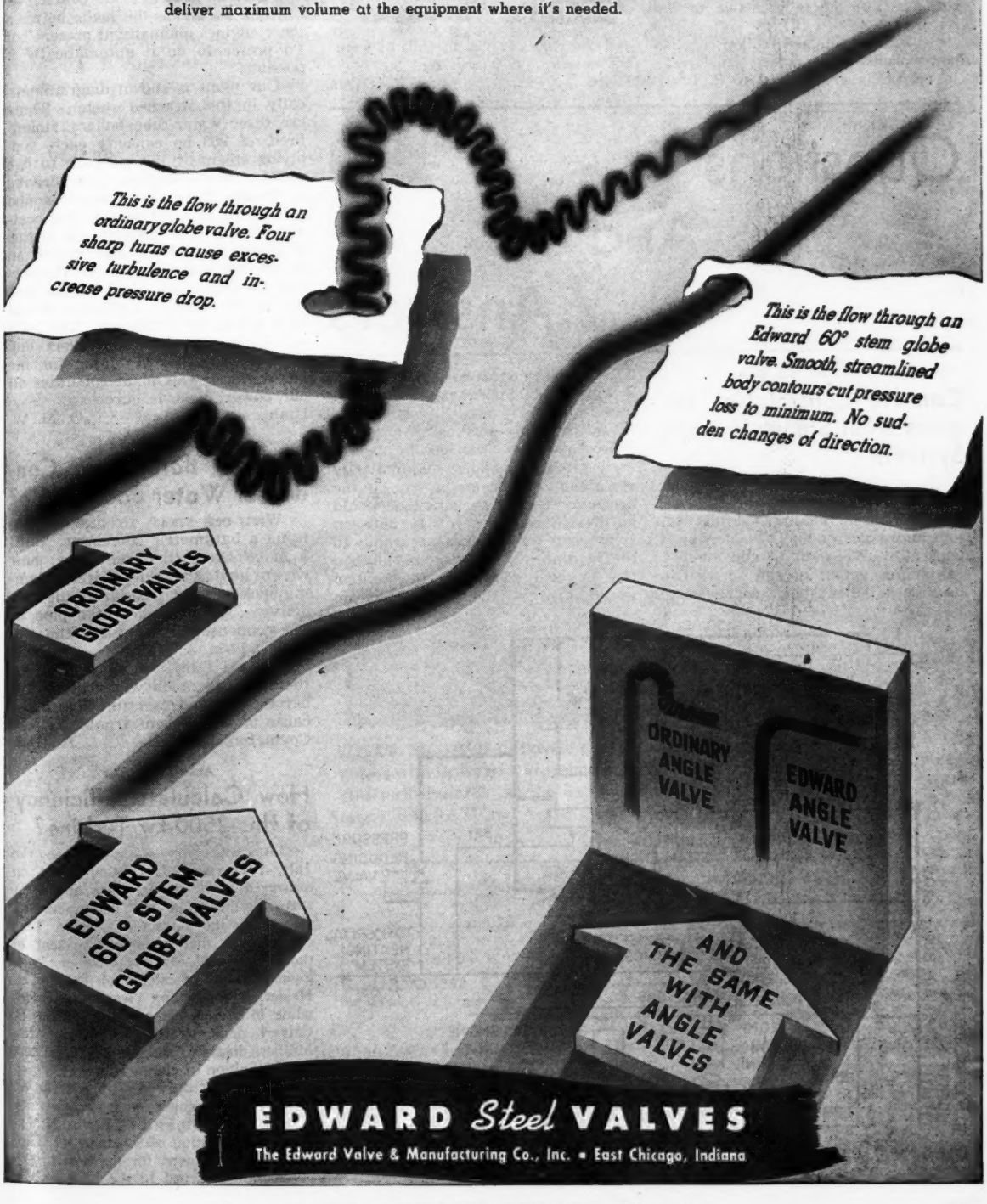
Education vs. Experience

"E IS FOR EXPERIENCE; there is no substitute!" To try to harmonize the views of Mr. Vancil F. Hill in the September issue and Mr. William R. Green in the November issue:—I think that neither Mr. Hill nor any other advocate of education means to imply that a college degree automatically qualifies a man to be senior operating engineer or boiler room foreman. Of course a college trained man in any profession, whether it be engineering, business, law, or medicine must have practical experience under proper supervision before being given full responsibility for a job. If this period of training is too short, however, or omitted altogether, it will naturally result in the "old timers" of Mr. Green's letter having a decreased respect for all college men.

After getting some practice in applying his education to practical problems, however, the college trained man will generally draw ahead of the man of equal natural ability who must depend upon experience alone. Why is this the case? To begin with, he has been able to learn in a short time fundamental laws and principles that both practical men and scholars have discovered by experiment and often bitter experience over centuries of time. This is something that many people do not understand; that education is, in effect, concentrated experience. Mr. Green recognizes the value of education by suggesting that the fireman study technical books and periodicals to prepare himself for advancement. But here again the college man has the advantage because he has the habit of study and he is better able to understand the language and fol-

Here's how Edward Valves cut waste and end costly pressure loss . . .

Pressure drop is a fuel thief. Pressure loss through your small globe and angle valves can be reduced greatly by standardizing on Edward forged steel valves. Compare these flow lines to see how streamlined Edward forged steel valves prevent the excessive turbulence that causes valve wear, let flow through with no sharp and sudden changes, and deliver maximum volume at the equipment where it's needed.


This is the flow through an ordinary globe valve. Four sharp turns cause excessive turbulence and increase pressure drop.
This is the flow through an Edward 60° stem globe valve. Smooth, streamlined body contours cut pressure loss to minimum. No sudden changes of direction.
ORDINARY GLOBE VALVES
EDWARD 60° STEM GLOBE VALVES
ORDINARY ANGLE VALVE
EDWARD ANGLE VALVE
AND THE SAME WITH ANGLE VALVES

EDWARD *Steel* VALVES

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low the reasoning of these works which are, sometimes, really technical.

Anyone who has studied engineering and related subjects, especially, has been trained to reason, to correlate cause and effect, and to ask, "Why do things work this way and why won't they work a better way?"

Then the college man has had enough ambition to prepare himself, often at considerable sacrifice, to hold a good position, and this same ambition often helps make him a valued employee. If he can save one tenth of a pound of coal per kwh he is profitable to his employer.

Now, how will more-college-men-in-power-plants affect present employees? In practically every issue of P. P. E. either the editor or some contributor is battling for more public recognition and more financial reward for power plant men. How can you expect to get it when both public and management thinks that any common, unskilled laborer, after maybe a few months as coal handler, is competent to operate a modern high pressure boiler or high speed turbine? Sure, licensing regulations are fine where they are in effect, but nevertheless, if we can convince employers that college men in power plants will be profitable for them, we will find it profitable for us, too, whether we have been educated solely in the University of Hard Knocks or in the halls of learning as well. Try it and see.

Provo, Utah — RICHARD P. HARRIS

Questions And Answers

Question No. 293

Can He Control Gas Engines from Steam Heating System?

IN OUR PLANT we have steam engines driving generators and exhausting to a large building heating system and a gas engine also driving a generator. We want to add another gas engine generator set, so we can use more boiler steam for heating. Also, our electrical load varies over a wide range and sometimes fluctuates rapidly.

Is there any sort of governor or control device we can get to operate the two gas engines automatically according to the steam pressure in the heating system so that the load would be divided automatically between steam and gas engines according to the heating system demand? When this demand decreased, the control would prevent the exhaust steam pressure from building up so much that steam must be wasted to atmosphere, as it often is now. When the heating system steam demand increased, the control would cause the gas engines to give up load to the steam engines so they would supply more exhaust steam.

I would be interested in knowing if such a control device can be obtained or manufactured and exactly how it would work. Also, are there any automatic control installations of this sort at present? Of course, we can and do divide the loads between these engines manually at present but I'd prefer to do it automatically if possible.

Our plant is shown diagrammatically in the attached sketch. There are three water-tube boilers, stoker-fired, of 200 hp capacity each, supplying steam at 150 psi gage to two uniflow steam engines, each driving a 150-kw, 220-v, d-c generator and exhausting at 5 psi gage to the heating system. The present gas engine is rated at 120 hp and drives an 80-kw, 220-v, d-c generator. The second gas engine set, which we are now getting for standby, I estimate should be a 100 hp or 75 kw unit. The fuels are Utah coal for the stokers and natural gas from Wyoming for the gas engines. This plant generates all our power; none is purchased.

Utah — O. M. W.

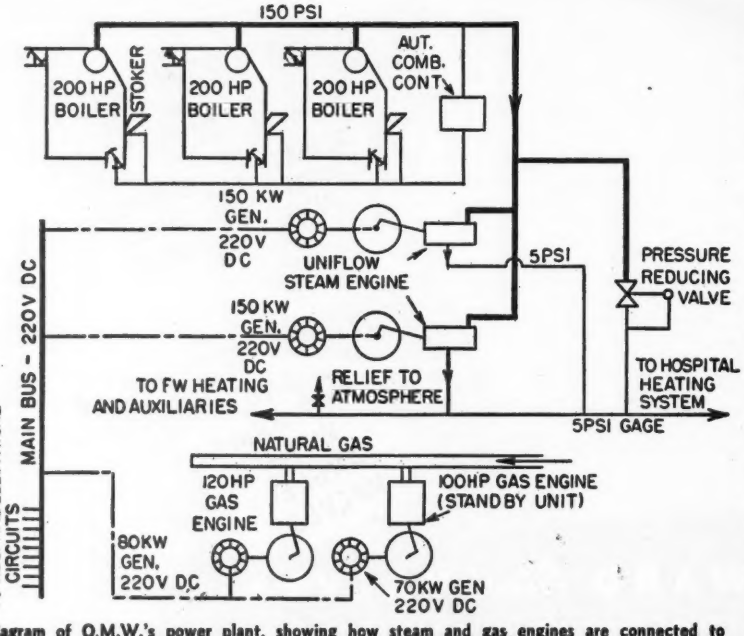

Diagram of O.M.W.'s power plant, showing how steam and gas engines are connected to supply heating steam and electric power

Question No. 294

Why Is Barometric Condenser Water Backing Up?

WITH OUR STEAM TURBINE, we are using a barometric condenser. Until 5 months ago it worked fine; now we are having trouble. Water is coming back to the turbine from the condenser. The cooling water pipe to the condenser is 6-in. and the tail pipe is 12-in.

What I'd like to know is: Can there be too much water used in a barometric condenser and what is the cause of our present trouble?

Covington, Ky. — H. G. S.

Answer No. 266

How Calculate Efficiency of this 2500-kw Turbine?

THIS QUESTION was asked in the July, 1944 issue, data being given on measured flows, temperatures and pressures as well as the manufacturer's water rate and extraction curves. Tear sheets from that issue will be sent to those interested. In the October, 1944, issue, methods of calculation by Messrs. Heidecker and Fox were presented, while in the December issue, Julian P. Calvert demonstrated the use of the Mollier diagram and the ASME test code definition of engine efficiency.

In studying the reply by Alfred W. Fox in the October issue, Ralph McKinney of the Brown Co., Berlin, N. H., raised the question of whether Mr. Fox should have allowed for the heat in the condensate returned to the boiler. Mr.

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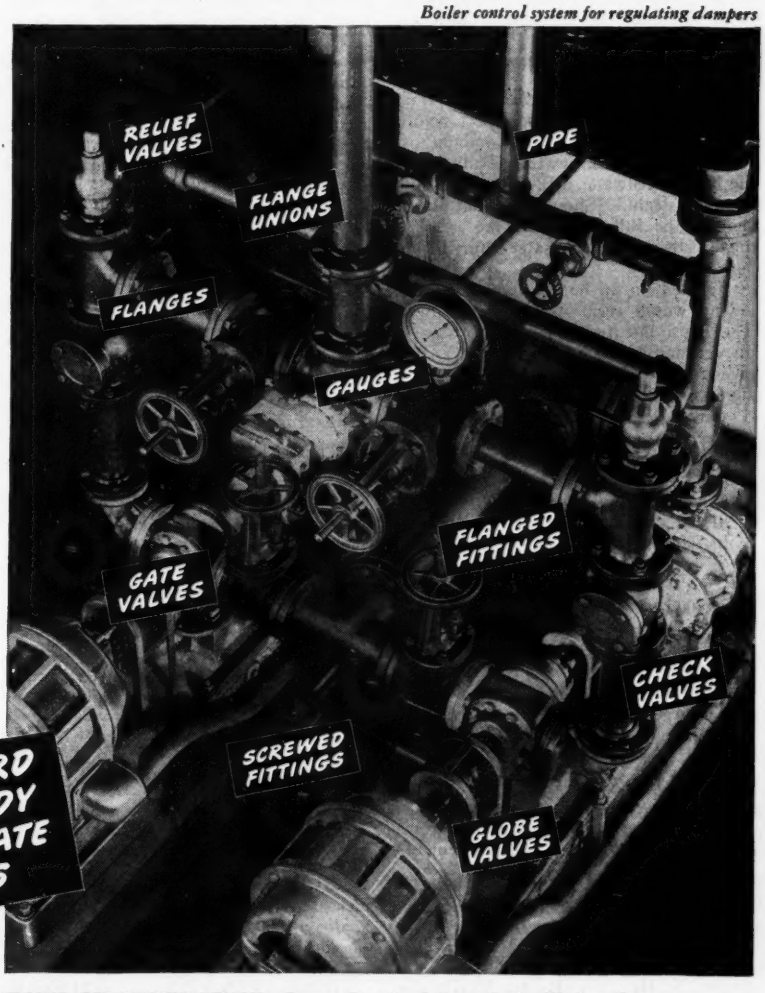
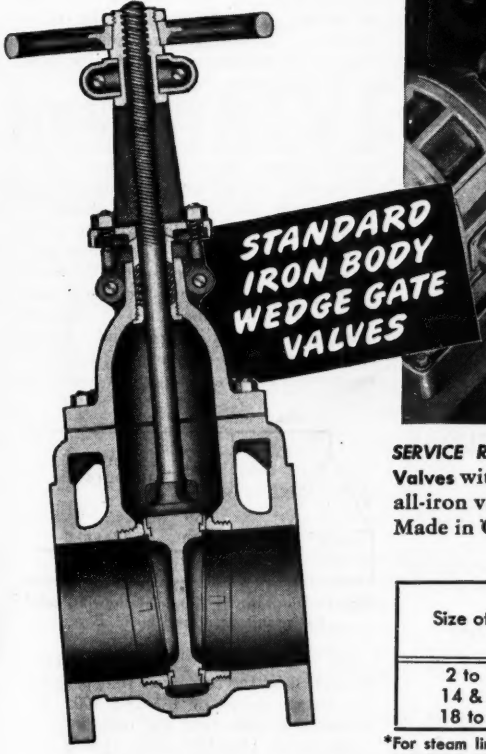
Boiler control system for regulating dampers





SERVICE RECOMMENDATIONS: **Crane Standard Iron Body Wedge Gate Valves** with Brass trim are recommended for steam, water or oil lines; all-iron valves for oil, gas or fluids that corrode brass but not iron. Made in O.S.&Y. and Non-rising Stem patterns.

Working Pressures

Size of Valve	Screwed or flanged end valves		Hub end valves
	Saturated Steam	Cold water, oil or gas, non-shock	Cold water or gas, non-shock
2 to 12 in.	125 pounds	200 pounds	200 pounds
14 & 16 in.	125 pounds	150 pounds	150 pounds
18 to 24 in.	*	150 pounds	150 pounds

*For steam lines larger than 16-in., Crane 150 pound Cast Steel Gate Valves are recommended. (For sizes under 2 in., use Crane Clamp Gate Valves.)

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Fox immediately explained why he had deliberately omitted this in his original answer and gave several additional examples showing the difference made in the answers by assuming various proportions of condensate return. With the full permission of both correspondents, their exchange of letters is given below, for they bring out several points of value to turbine engineers in making efficiency calculations.

Should Condensate Return to Boiler Be Allowed For?

IN MR. FOX'S ANSWER to Question No. 266 in October, POWER PLANT ENGINEERING, in arriving at the amount of steam chargeable to power, he subtracted the Btu in feedwater to Boiler from total Btu in steam. Should he not have charged the full Btu to turbine and deducted Btu in condensate returned to boiler?

Treated on an hourly basis, the following would seem to be the solution. The 5 psi line to feed water heater is disregarded, as amount of steam was not given:

Input to Turbine, 81,300 lb per hr containing 1,236.3 Btu per lb

Extracted for Process, 63,700 lb per hr containing 1,176.9 Btu per lb

Turbine Exhaust, 17,600 lb per hr at 77 F = 45.0 Btu per lb

81,300 × 1,236.3 = 100,511,190 Btu

63,700 × 1,176.9 = 74,968,530 Btu

25,542,660 Btu *

17,600 × 45.0 = 792,000 Btu ‡

24,750,660 Btu §

* Used for power

‡ Returned to boiler house

§ Chargeable to power = 24.6 per cent

Average hourly output of Turbine 1,880-kw = 6,416,440 Btu

$\frac{6,416,440}{24,750,660} = 25.9$ per cent = efficiency of turbo-generator as a power producer.

At ¾ load generator is 94.8 per cent efficient.

$\frac{25.9}{94.8} = 27.3$ per cent = efficiency of turbine and condenser as a power producer.

Berlin, N. H. RALPH MCKINNEY

Calculations by Fox with Process Returns and Make-Up Assumed

AS MR. MCKINNEY has pointed out, there was a slight intentional error in the writer's answer. The original question supplied no data on the quantity of condensate returned by process nor on the percentage of make up water used. The writer attempted to dodge the issue raised by Mr. Kinney by assuming sufficient exhaust steam returned from boiler feed pump and auxiliary process equipment to heat all condensate from both process and power to the feed water temperature of 227 F. This assumption was made to provide R.B.M. who asked the original question, with a relatively simple method of determining the percentage chargeable to electric generation and the result obtained was considered sufficiently accurate for the purpose.

The writer wishes to point out that it is impossible, in his opinion, to obtain a much more accurate answer without the data mentioned above. Whereas we may disregard the 5 psi steam, we should not completely disregard the heat in the condensate returned from process. If due allowance were made, Mr. McKinney's method would give the correct answer. His solution makes use of data from steam tables based on 32 F. Because his balance is not quite complete, a slightly different answer would result if the tables were based on, say 53 F, the temperature of the make up water. The percentage, obviously, should not change.

This point will be demonstrated in the following examples. But before presenting them the writer wishes to emphasize the fact that the percentage of fuel chargeable to power should be the excess amount consumed when generating electricity compared with the amount consumed if no electricity were generated, that is, for generating dry saturated steam for process at 43 psi gage from feedwater at the weighted average temperature of 158 F condensate and 53 F make-up. The writer will disregard reduced steam consumption of boiler feed pump, reduced furnace radiation losses, altered boiler efficiency, etc.

Example 1.

Assume 100 per cent of 158 F condensate from process and 0 per cent make up.

Using Mr. Kinney's figures and crediting process condensate in the same manner as power,

63,700 × 1,176.9 = 74,968,530

63,700 × 126 = 8,026,200

Chargeable to process = 66,942,330

Chargeable to Power = 24,750,660

Total 91,692,990

Percentage chargeable to power = $\frac{24,750,660}{91,692,990} = 27$ per cent

Example 2.

Assume 0 per cent return of condensate from process and 100 per cent make up at 53 F. In this case process should be credited with 53 F return, not 32 F.

63,700 × 1,176.9 = 74,968,530

63,700 × 21 = 133,770

Chargeable to process = 74,834,760

Chargeable to power = 24,750,660

Total 99,585,420

Percentage chargeable to power = $\frac{24,750,660}{99,585,420} = 24.8$ per cent

Example 3.

Assume 40 per cent make up.

63,700 × 0.6 = 38,220 lb per hr at 158 F, 126 Btu

63,700 × 0.4 = 25,480 lb per hr at 53 F, 21 Btu

Then

38,220 × (1,176.9 − 126) = 40,200,000

25,480 × (1,176.9 = 21) = 29,500,000

Chargeable to process = 69,700,000

Chargeable to power = 24,750,000

Total 94,450,000

Percentage chargeable to power = $\frac{24,750,000}{94,450,000} = 26.2$ per cent

It is evident that the writer's answer was approximately correct and fairly close to that obtained from the correct analysis suggested by Mr. McKinney if due allowance is made for process returns. In any event, there are other minor items directly chargeable to power such as condenser auxiliaries, which would have to be added if a truly correct answer were desired.

Westbury, L. I., N. Y. ALFRED W. FOX

IN POINTING OUT a minor error on your part I was guilty of a greater one by assuming no return from process and that make-up water was at 32 F. Thank you for bringing this to my attention.

You may be interested to know that, while in your part of New York state, the make-up water has an average temperature of 53 F, here in northern New Hampshire it is only 47 F.

RALPH MCKINNEY

Why High Potential to Ground But Little Current?

Answer No. 277

The Current Has No Place to Go

FROM THE VOLTMETER READINGS obtained by H.E.A., it is evident that none of the delta-connected coils of the transformers is grounded at any point, hence the voltage readings obtained have little or no significance.

It will be seen from Fig. 1, which is a diagram of the circuit described by H.E.A., that while the voltmeter is connected from a phase to "ground" there is no true circuit path through which current can pass to the other phases, as would be the case if one of the other phases was grounded. The circuit path may be said to be "dead-ended." However, a certain amount of current, even though it may be measured in milliamperes, will flow into the ground. Its intensity will be in proportion to the capacitance and resistance encountered therein.

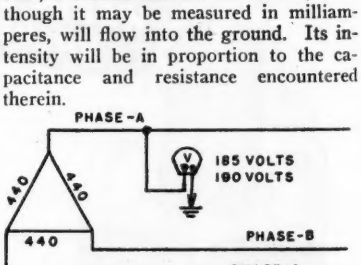

Fig. 1. Diagram by Kendrick showing original circuit described by H. E. A.

It is this small amount of current multiplied by the resistance that produces the voltage drops of 185 and 190. For example, assume that the resistance encountered is 1,000,000 ohms, that is, one megohm, then 0.000185 ampere would produce the 185 v indication. This small amperage, of course, would not be recorded on an ordinary ammeter.

The condition which has given rise to H.E.A.'s question bears a certain relation to the voltmeter method of measuring the resistance on insulation, a method with which H.E.A. is no doubt

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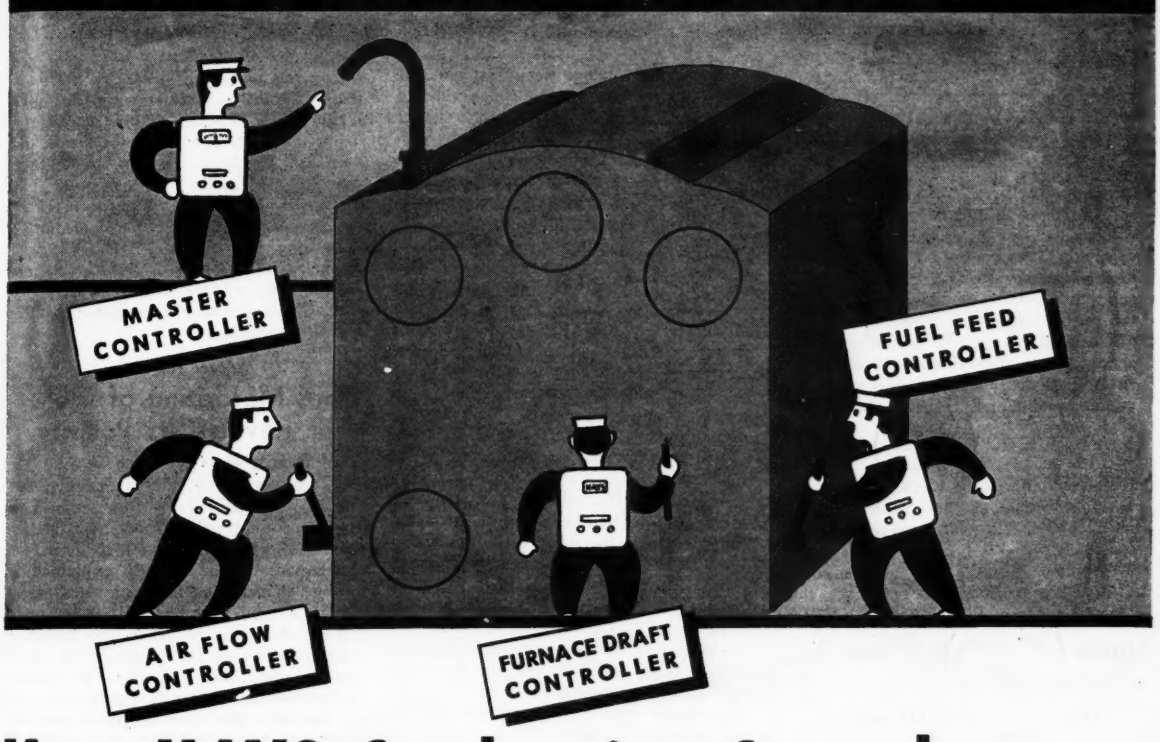

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5. Elements of a good controller.
6. *Coordinating* the controllers.
7. Selecting the best system for your needs.
8. How Automatic Combustion Control operates.
9. How each individual controller operates.
10. How controllers are calibrated and adjusted to fit requirements.
11. How controllers are stabilized to prevent hunting or over-travel.
12. Typical installations of Automatic Combustion Control.

IT'S LIKE HAVING a smart, tireless four-man crew on the job—the boss (Master Pressure Controller) who waits for the call from the plant for more steam, then calls on the others to give him the necessary cooperation; the two men who control the Air (Air Flow Controller) and Fuel (Fuel Feed Controller) respectively; and the man who keeps the furnace draft constant (Furnace Draft Controller).

To a central panel come reports of every fluctuation in every combustion factor, to be recorded and measured. Instantly accurate impulses go from the Master Controller to the Air and Fuel Controllers. These subordinate controls in turn transmit their impulses instantaneously to the damper or air control device and to the fuel feed device. Thus steam generation is ***kept in practically perfect balance constantly.***

You can see the many advantages—big savings in man-hours, important cuts in fuel bills, greatly reduced maintenance. A big help in relating those benefits to your business is the Hays Visual Presentation of Automatic Combustion Control. A Hays Engineer can show it to you—no obligation, of course. A note to us will arrange it.

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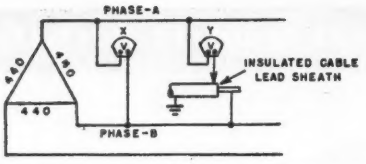


Fig. 2. Diagram by Kendrick comparing the grounded condition with insulation resistance measurement

familiar. In Fig. 2, voltmeter X, placed across phases A and B reads the circuit voltage, in this case 440. If now the voltmeter Y is connected from phase A to the lead sheath of a cable whose insulation resistance is to be measured and the conductor of the cable connected to phase B, a voltage will be indicated, depending upon the value of the ohmic resistance of the insulation. This resistance value is obtained from the following formula $R = R_v \left(\frac{V_x - V_y}{V_y}\right)$ in which

R = Resistance to be found
R_v = Resistance of the voltmeter
V_x and V_y = The voltmeter readings, respectively.

Assume that the voltmeter used by H.E.A. has 100,000 ohms resistance, then the resistance of the ground path will be

$$100{,}000 \left(\frac{\frac{440}{185} - \frac{185}{185}}{185}\right) = 138{,}000 \text{ ohms}$$

$$\text{Then} \frac{}{138{,}000} = 0.00134 \text{ amp.}$$

or 1.3 milliamperes which represents the value of amperage actually flowing into the ground.

Baltimore, Md. JOSEPH A. KENDRICK

Answer No. 283

Why Is Water Level Hard to Control?

Be Sure Regulator Is Correctly Installed

FROM THE INFORMATION given by G. B. regarding conditions in his plant, I am led to believe that the load variation is the primary cause of his trouble in controlling the boiler water level in the new bent-tube boiler.

I assume that the new boiler is equipped with automatic steam pressure control apparatus, while the two older boilers are controlled manually. In this case, the new boiler would operate at a range of 50 to 200 per cent of normal rating, which is a conservative estimate.

When the steam output of the new boiler is reduced, the water level will drop, the feedwater regulator will then open and restore normal water level, a load increase then will cause the boiler to operate at a higher rating and the water will go to a higher level than is desirable.

This will occur even with the feedwater regulator working perfectly and is due to increased ebullition within the boiler. If load changes occur at short intervals, it is probable the feedwater regulator will become inoperative due to the movement of hot boiler water to and from the lower connection to the thermostat element. Should this hot water pass the lowest point in the piping it will rise immediately to the thermostat element with sufficient heat to expand it and cause the feed control valve to open up when it should be closed.

I know of one installation that on extreme load change would throw the feedwater regulator wide open due to a sag in the pipe between the boiler drum and the lower end of the thermostat, the sag or low point was 4 ft from the boiler where it could have been 10 ft. The piping was corrected and the trouble ended.

I would suggest that G. B. check the position of the feedwater control valve especially at high water level, to ascertain if it is sticking or if it is failing to close for any other reason such as hot thermostat tube. Also check for leakage of the blowdown valve usually placed in this line, this pipe should be nearly room temperature. His trouble may also be caused by scale or other obstruction in the circulating tubes of the boiler.

I would also suggest that steps be taken to equalize the variation in steam output on all the boilers, as the water level in the old boilers remains normal it is evident that there is little variation in their output when a load change occurs.

It is my opinion that placing iron plates along the sides of the dry pipe may help prevent carry-over, but to do this would only be making the best of an undesirable condition.

Elmira, N. Y. FRANK HOSKINS

Another explanation of and cure for the difficulty is offered by John P. Badenhausen of Philadelphia, Pa. He states that in G. B.'s four-drum bent-tube boiler, when the steam demand increases rapidly, causing a drop in boiler pressure, there is a tendency for the water in the bottom drum or so-called mud drum to change from water into steam. This sudden expansion of the water in the mud drum forces the water to relieve itself, pushing the water and steam mixture up into the upper drums and tending to start priming.

This action, he says, produces a wide difference between the water levels in the three upper drums, as shown by numerous tests. In some cases, he points out, the water level in the front drum may rise or fall several inches below normal, while the level in the rear drum may fall so much that there will be a difference of from 20-in. to 4 or 5 ft between the rear and front drum levels. The level in the middle drum remains more nearly at the required normal although it too will fluctuate somewhat.

To prevent priming under such conditions, Mr. Badenhausen advocates reducing the amount of water in the mud drum, so that no excessive swelling will occur, by the installation of a secondary removable displacement drum inside the original mud drum, with sufficient space for feeding water to the tubes but temporarily isolating the great mass of this mud drum water from immediately expanding its volume. This secondary displacement drum installation, a patented device of Mr. Badenhausen's design, is called a throttling diaphragmatic priming preventor.

Answer No. 285

Does Motorizing of Generator Reverse Its Polarity?

Field Polarity Stays the Same

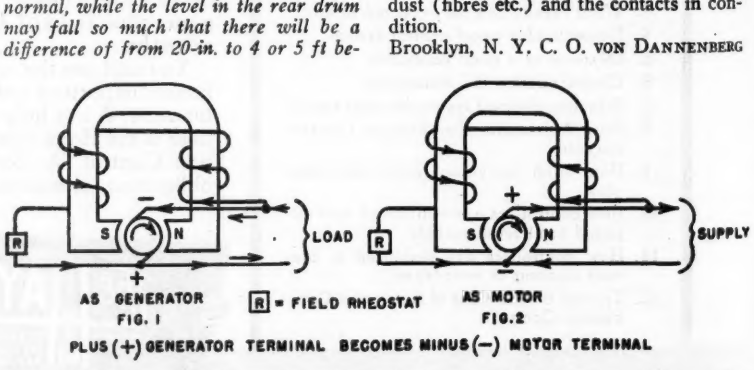
THE GENERATOR in this instance, being a shunt-wound machine, maintains the same field polarity whether operating as a generator or motor. This is a fundamental basic relation explained in every elementary textbook describing details of generation as well as the principles. Actually, however, the direction of armature current changes, from which we have this basic principle: To operate a shunt-wound motor as a generator, and to maintain the same terminal polarity as it had when operating as a motor, it must be revolved in the *reverse* direction to that in which it revolved as a motor.

The appended elementary diagrams are intended to indicate the changes in the current flow of a battery-charging generator for the conditions referred to.

Actually, what happens is the lowering of the induced generator voltage to such a value that the battery voltage is actually higher and the direction of the current in the line connections or rather the terminals of the armature changes as indicated; the shunt field being merely a branch circuit to the armature circuit and, as shown by the arrows, has the current flow in the same direction in the field circuit for either condition, i.e., the same polarity.

Incidentally, modern type reverse current relays should be little trouble and will function correctly if kept free of dust (fibres etc.) and the contacts in condition.

Brooklyn, N. Y. C. O. VON DANNENBERG



Figs. 1 and 2. Diagrams by von Dannenberg showing how field polarity remains same for generator operating as motor

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Answer No. 289

The Mystery of the Missing NH_3

SHADES of Ellery Queen, Asy Mayo, Hercule Poirot, Sherlock Holmes and the rest!—not to mention Dick Tracy! Maybe it's not a mystery at all. We've certainly had a flood of answers on this one. Some of the brethren have had similar experiences and have found the answer.

The question, asked in the February issue by W. E. D. was: What becomes of the $25 drum of NH_3 he has to put into his refrigeration system every month? What sort of leaks should he look for? Here are just a few of the tips from other engineers.

Look for Leaking Head Gasket

The case of W. E. D.'s missing ammonia was interesting to me. However, it is not so mysterious if one or more of his compressors are of the head-jacketed type. Sudden, or sometimes gradual, changes in the temperature of the heads will cause the gaskets to leak. This is especially true if the gaskets are of lead, since

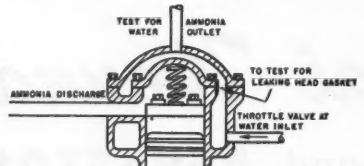


Diagram of head-jacketed compressor, by Holman, showing how to test for gasket leak

this metal is less resilient than the usual asbestos material. A small leak with head pressures above 150 psi could easily account for the loss of 100 lb of NH_3 monthly.

If the jacket cooling water is spilled to sewer, large quantities of absorbed ammonia could be carried away without detection. Also, this would probably be the case if the jacket cooling water were mingled with the condensing water, and recirculated over a cooling tower. Ammonia may be so lost to atmosphere as fast as it is absorbed, and without being noticed.

W. E. D. can check on his head gaskets without opening the jackets—assuming that his compressors are of this type. He needs only throttle either inlet or outlet valves for a few minutes at most, and test the heat-laden water with litmus paper. If the leak is severe enough to permit the loss of 3 or 4 lb. NH_3 daily, the test paper may not be necessary. W. E. D.'s nose may make the detection.

Marissa, Ill. GEORGE HOLMAN

A Trouble-Shooter Says Smell the Cooling Tower

HAVING BEEN a trouble-shooter for a large meat packing company a few years back, the problem of the missing NH_3 which is bothering W. E. D. seems quite simple to me. If he will climb up on the roof of his plant, he will no doubt smell where his ammonia is going. He apparently has some bad tubes in the condenser bank and the ammonia is being carried through the cooling system and out through the cooling tower.

This is not an uncommon occurrence for I remember several similar instances of this nature. One time in particular we were called to go from Danville, Ill., to Petersburgh on a rush job and as we were driving through Decatur, the engineer we were riding with was pointing out the company plant in Decatur where I had never been. I said we had better stop here now as they have a bad ammonia leak someplace.

Well, we stopped and sure enough they were losing ammonia through the cooling tower. We worked all night and half the next day and then went on to the other job. This particular plant had a drum condenser and we merely rolled in two new tubes and the trouble was solved. Hope this helps W. E. D.

Washougal, Wash. W. E. SHIGHT

He Found a Leaking Flange on Cylinder

I HAVE HAD a similar experience to the one described by W. E. D., which took me quite some time to locate. In my case, the ammonia would get away only in the summer months when all the ammonia machines were in operation. During the fall, winter and spring, we never had to charge any ammonia into the system. We finally observed that our ammonia trouble started when we put into operation one certain machine, although we could detect no ammonia smell anywhere.

This machine is a horizontal, double-acting, steam-driven machine, 16 by 42 in., with an open-type water jacket around the ammonia cylinder. We found a flange joint leaking where the discharge manifold bolts on to the cylinder. This flange is covered by about 6 in. of cooling water when the machine is running and consequently the water absorbed the ammonia and carried it off to the sewer. When the machine was shut down, the valves were closed. There being no pressure in the cylinder, the leak was not detected.

We found this leak because the discharge water line from the water jacket of the machine to the sewer would corrode and clog up, while the other machines using the same water did not.

This is just my experience and may not be any good to W. E. D., but he is welcome to it just the same.

Newton, Kans. LELAND M. KENAGY

He Is Not the Only One

W. E. D. IS NOT the only refrigeration engineer who has wondered what happened to the ammonia put into the system. For a 110-ton plant, a cylinder of ammonia per month does not seem too far out of line, considering the inevitable loss through chemical change within the system, minor accidents, loss during necessary changes in piping, etc. The amount to be replaced will, of course, depend on a number of factors.

A plant of this size no doubt has an automatic air and foul gas purge, which, by the very nature of the brute, is bound to lose a little ammonia. Any oil that is caught in traps and coils and blown out of the system carries with it a good deal of ammonia. Similarly, periodic draining of the old oil from a compressor crankcase will result in the loss of NH_3.

There may be an undetected leak of ammonia, either out somewhere in the open air or from the condenser into the cooling water. If the water leaked into the ammonia system you would find out about it in a hurry. The ammonia, being at the high-side pressure, as against the usual water pressure of a few pounds, will go the other way and a pinhole in a condenser tube can throw away a lot of refrigerant. If a large amount of make-up water is used in cooling such a loss might very well be undetected by smell. I would suggest draining the water out of the condensers and looking for leaks there.

Flagstaff, Ariz. HAROLD S. SYKES

A Number of Points to Check

W. E. D. STATES that he has checked the piping and valves for NH_3 leaks.

No doubt he has also checked the stuffing boxes of the compressors. However, he may have overlooked the following possible sources of NH_3 loss:

1. From the condensers into the cooling water.
2. From the evaporator coil into the brine, if a brine system is used.
3. From other evaporators, such as in water coolers.
4. Losses from purging.

Besides the above, it is possible that small piping leaks have been overlooked, especially if any pipe is located out of doors, or if the pressure carried is very low.

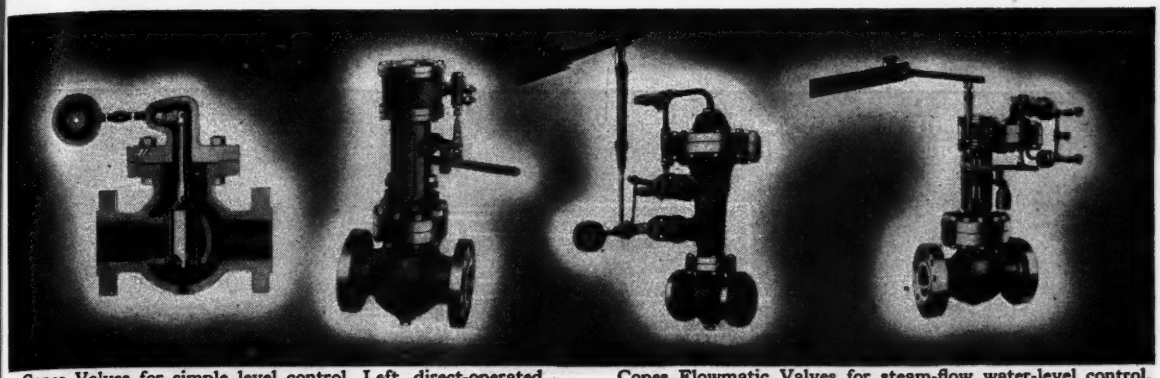
Leaks at points where the piping goes through a wall, and at points where the piping is supported by a clamp, are sometimes difficult to locate. External corrosion on sweating pipes is much greater at these points.

Also if the safety valve outlets are piped to outside, the outlets should be checked for leakage. The cooling water from the condenser can be checked with litmus paper. The brine could be tested with Nessler's solution.

In some plants evaporator coils are used for cooling water, which is in turn used for cooling other material. This water should also be tested, if such a cooler is used.

In testing for leaks in low pressure return piping, it would be better to carry a higher pressure while making the test.

St. Louis, Mo. JESSE L. ERISMAN



Copes Valves for simple level control. Left, direct-operated. Right, relay-operated.

Copes Flowmatic Valves for steam-flow water-level control. Left, direct-operated. Right, relay-operated.

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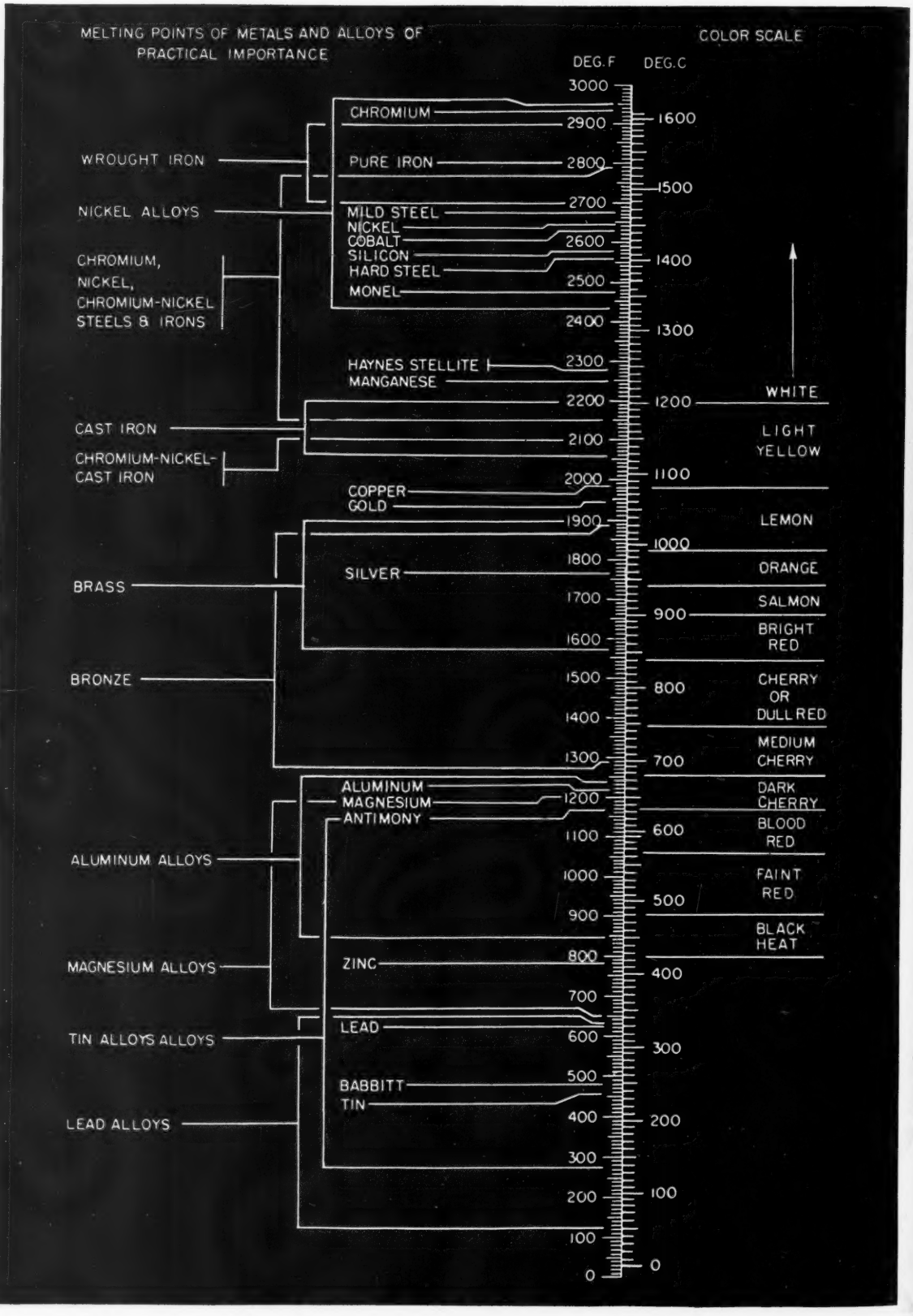

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Grand Coulee

(Continued from page 92)

On the steel structures spanning the transformer transfer track are also mounted de-icing switches. In case spray from the spillway waterfall causes ice to form on the conductors which connect the transformers to the switchyards, a circuit so affected can be cut off from the generator and from the switchyard buses, short-circuited at the switchyard, and connected by means of the de-icing switches to a station-service unit, at low voltage. Building up the station-service generator field circulates sufficient current through the line to heat and relieve the ice-burdened circuit.

Four mats of bare copper cable of 200,000- to 500,000-circular-mil section, one under each power house and one under the riprap on each tail-bay, provide ground connections for all electrical equipment. Cables connect the ground mats to 750,000-circular-mil cables, which extend the length of the power house and serve as main ground-buses. Ground connections between plant equipment and the ground-bus can be opened for testing purposes.

Switchyard Details

The left 230-kv switchyard consists of 18 bays, in which the 230-kv transformer circuits from the power house terminate, and from which outgoing transmission lines extend. The switchyard is of the double bus arrangement, with bus-sectionalizing switches provided to separate each bus into four sections. A loop circuit is provided to connect the bus sections at opposite ends of the yard together, to facilitate switching. An 8-cycle, 230-kv, 2.5-kva interrupting-capacity oil circuit breaker is provided on the circuit from the transformer bank of each generating unit to each 230-kv switchyard bus.

Of six outgoing 230-kv transmission lines, two parallel lines extend to each of three load centers. Four of these lines have single, 3-cycle oil circuit breakers, but two of the lines have two 2-cycle breakers, one to each of the two switchyard buses. All but two of the 3-cycle line circuit breakers are of conventional construction. The other two line circuit breakers are of the oil-blast design.

A somewhat unusual or interleaved connection of transmission lines is normally used, in which one line to each load center is connected to each of two main buses, rather than in the more common arrangement in which both lines to a load center are paralleled at both ends. This interleaved connection of transmission lines affords advantages in increased flexibility and system transient stability, but since more lines and generators must be connected together, it requires a somewhat greater interrupting capacity in line circuit breakers, hence 3.5 million-kva interrupting capacity was specified for the more recently purchased line breakers, and those originally constructed were converted to this capacity.

A few bays of a similar but smaller 115-kv switchyard have been completed, near the left 230-kv switchyard. Two 115-kv transmission lines are served at present.

Lighting

The lighting system for the power house is in reality two separate systems, one system for the control and service bays and one system for the main generator bays. Both systems are fed from the same dual 6900-v feeders.

The control and station-service bays are lighted by a 115/199-v 4-wire, 3-phase system deriving its power from two banks of three 6900/115-v transformers. The transformers are connected to the 6900-v feeders by hand-operated, fused, selector switches, so that they can be transferred from one feeder to the other, as required. Energy for lights in the generator room is supplied by a 115/230-v single-phase system, with supply transformers located in alternate bays. These distribution transformers can also be connected by hand-operated, fused, selector switches to either of the two 6900-v feeders.

An emergency source of light is provided for certain areas by lamps served by the 250-v station-service battery. This system is interlocked with the normal alternating current lighting circuits so that it will cut in automatically in event of failure of the normal lighting service. The direct-current lights are located over each generator control board, over the 460-v and 6900-v distribution boards, and in the main control room.

Heating and Ventilation

The heating and ventilating system is made up of intake fans, ventilating ducts with built-in heaters, control louvers, and exhaust fans. In addition, space heaters are provided for supplemental heating. Except in the control room, no cooling has been provided except that obtained from the walls of the lower galleries, which are adjacent to the penstocks and below the level of the water in the tailrace.

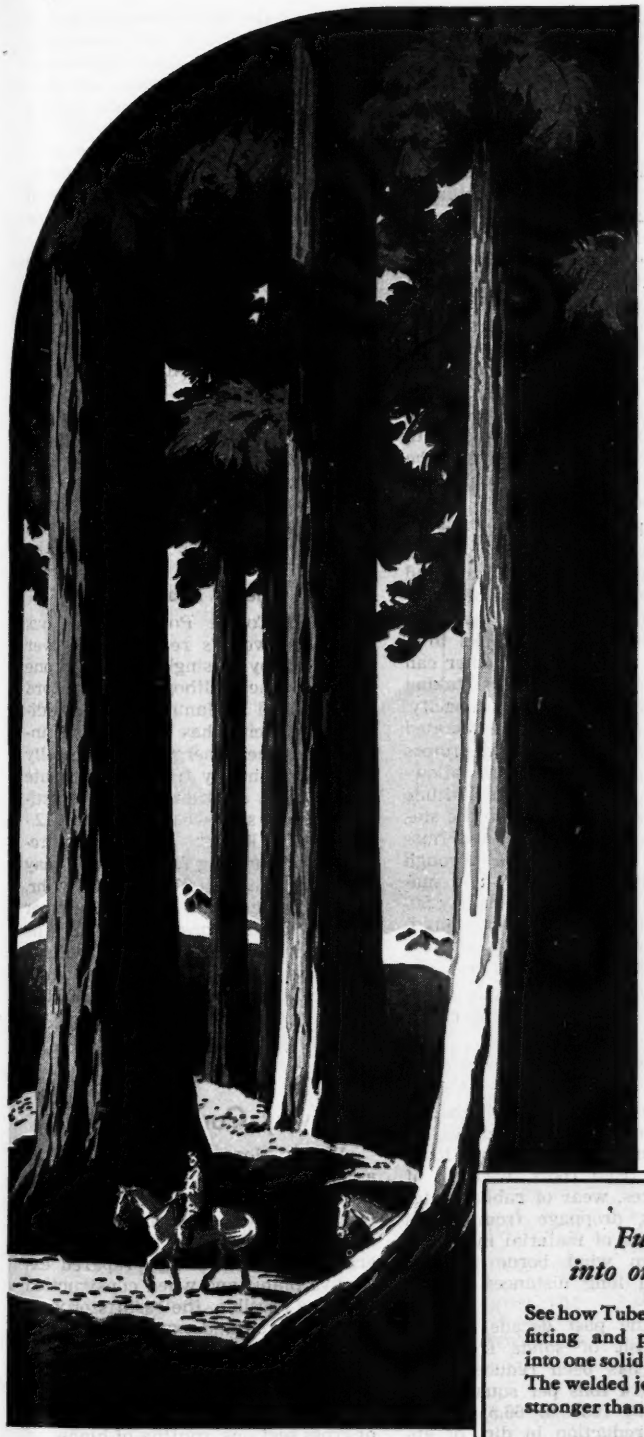
In normal summer conditions, air is taken into the building through adjustable louvers located in the upstream wall. This air, 30,000 cfm, is forced through ducts to the lower galleries in the main generator and service bays by 10 circulating fans, and allowed to rise through the building. The air is then exhausted by three fans, located near the ceiling of the main generator room. Air circulation in the control bay is controlled mainly by one fan with a capacity of 40,000 cfm. This fan is located in a plenum chamber into which 15,000 cfm of outside air normally is mixed with 24,500 cfm of inside air and forced through ducts to the individual offices. From the offices, the air is allowed to return through the corridors to the air shaft, and thence to the plenum chamber, or to be exhausted through the roof. In the ducts leading to the main control room, the air may be cooled by a cold-water radiator installed for this purpose. Besides the air exhausted from the air shaft, a system of exhaust fans has been installed to remove all the air from the machine shop, oil room, toilet rooms, and battery room. A fan is also connected to the air return from the main control room so that this air can also be discharged without being recirculated.

During winter months, heating is provided by electric heaters in the intake ducts, and space heaters built into recesses in the walls of the building. The majority of the latter are equipped with motor-driven fans for circulation of air, and thermostats for automatic maintenance of temperature in the vicinity of the individual heaters. The installed heating capacity is in excess of 3,000 kw. It is estimated that this will be sufficient to maintain temperatures of 65 and 70 F in the operating galleries, and 45 F in the generator room during the lowest probable outdoor temperature.

Oil, Air, and Service-Water Systems

Storage tanks for lubricating oil and insulating oil for the left power house are located in a vault in the extreme end of the building, beneath the deck north of the control bay. Two 18,000 gal tanks are provided for insulating oil, and two 5,000-gal tanks are provided for lubricating oil. Supply and drainage headers for each class of oil extend the length of the power house for local valve connections to the equipment served. Pumps for transfer service, are located in a room adjacent to the tanks. Provision is also made there for a combination centrifugal and filter-type purifier, although a portable centrifugal purifier and filter press is provided. Fire protection for the oil storage space is furnished by a supply of liquid carbon dioxide in high-pressure cylinders, with pipe and nozzle connections through which the gas can be released by means of an electrically operated valve, actuated by any one of several thermostats distributed about the storage room. Oil storage capacity of 19,000 gal is also provided in the left switchyard for the oil circuit breakers. Oil piping extends from the switchyard oil house to each circuit breaker, and a line connects it with the storage tanks in the left power house.

Compressed air at a pressure of 100 psi, for manual and automatic operation of the generator brakes, and to supply a system of convenient out-



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lets for portable tools and general cleaning, is supplied by three V-type semi-portable air compressors and one horizontal compressor with an aggregate capacity of 1300 cfm. The compressors and receiver tanks are located in the pump and compressor room, adjacent to the oil handling equipment. Separate air compressors are provided in the dam for the ice-prevention, air bubbling system.

Water for cooling the generators and transformers is supplied by water-jet eductors, which lift water from the tailrace by use of high-pressure water from the penstocks. Domestic water is obtained by chlorinating river water. This supply will eventually be supplemented by water from pumps which drain the slide area of the bank above the left tailrace.

Two main water-drainage headers run the length of the plant, one for general floor drainage and the other for unwatering the penstocks and draft tubes. These terminate in sumps in the control bay, where motor-operated pumps automatically maintain the water level below fixed elevations.

For the sewage system, two septic tanks are installed at a level above the normal tailwater elevation. Drainage pumps are provided for the drainage lines below the level of the septic tanks.

Transportation and Handling Facilities

For use in constructing the dam and power houses, a railroad spur was extended to the dam from the nearest railroad junction, at Odair, Washington, about 25 miles distant. This railroad connects by switch sidings to a large utility building located near the left abutment of the dam. This utility building is used for the storing of large equipment, sandblasting, painting, and the partial assembling of heavy equipment. The building houses a 75-ton gantry crane, which also travels over the sandblast area and a portion of the storage area. The railroad extends to the project warehouse, and thence to the power house and onto the service-bay main deck, through the large door in the abutment end of the building. A similar large door opens from the service bay to the transformer deck, for handling the main transformers. Access from the utility building to the power houses and other parts of the project is also had by a 16-wheeled, 200-ton trailer, which can reach the right side of the river by crossing the top of the dam.

Two double-trolley bridge cranes are provided in the left power house, each equipped with two 175-ton and two 30-ton hoists. By means of structural steel equalizers, one crane can apply both of its large hooks to a load, or the two cranes together can make an 875-ton gross lift, taking advantage of their overload capacity. The handling capacity was dictated by the necessity of handling the rotors of the main-unit generators, allowing the manufacturers some latitude in their design. Deliveries to the station-service power plant and machine shop can be made through hatches in the service bay and machine shop floors. A single-trolley 50-ton bridge crane with a 12-ton auxiliary hoist was installed in the station-service generator room.

Out-of-door cranes include a 14-ton single-leg gantry traveling crane, located on the draft-tube-gate bridge of each power house, for raising and lowering of draft-tube bulkheads. Two 150-ton gantry cranes are provided, one on each abutment section of the dam, for handling the 115-ton coaster gates which close the penstock intakes. Twenty-five-ton moveable hoists on the latter cranes will handle emergency stop logs. The main transformers, situated on the deck between the power house and dam, are equipped with wheels which permit them to be moved onto a motor-driven transfer car that travels on lower tracks parallel with the power house wall. Additional tracks through the door into the service bay provide for moving the transformers from the transfer car into the building, for maintenance purposes. Miscellaneous construction, repair, and service work is provided for by derrick barges on the reservoir behind the dam, and on the river below the dam.

Energy Available

Grand Coulee Power Plant has taken the world's record for power generated by a single plant in one month's time. Although this record was reached in January, 1944, additional capacity has since been installed. The energy economically available annually from the ultimate development at Grand Coulee is estimated to be somewhat more than 12,000,000,000 kw-hr. Annual requirements for pumping for irrigation may ultimately reach 1,970,000,000 kw-hr, all available from surplus summer water. Local consumption in the plant, dam, and associated village may reach 85,000,000 kw-hr annually, leaving more than 10,000,000,000 kw-hr of energy for sale.

Fighting Chicago's Air Pollution

(Continued from page 81)

rection of this type of emission requires much more technical effort and application than does the abatement of the average visible smoke case. The harm done by plants discharging excessive amounts of dust and noxious sulphate gases, however, is much greater than that done by a stack emitting visible smoke, and great strides are being made in the abatement of former bad nuisnaces that were tolerated a decade ago, simply because they were not recognized.

Air Pollution Tests

In order to chart the progress made in reducing air pollution, the department makes monthly tests of the amount of dirt settling over the Chicago area. This dirt originates from many sources—among which are fuel and garbage burning as well as sources other than chimney discharge. Dust may emanate from various industries, wind erosion of soil, loose dust blown from roofs, wearing of street surfaces, wear of rubber automobile tires, droppage from trucks on city streets of material in transit and is often wind borne in dust storms from long distances outside the city.

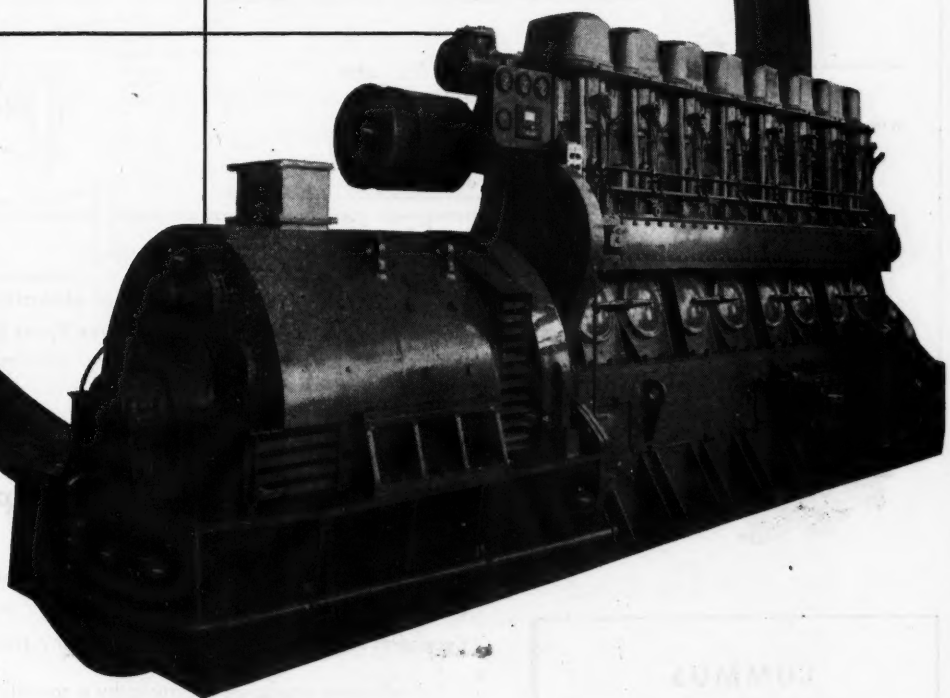
During the past decade the recorded deposit of solids from the atmosphere has been reduced from a total of 96.4 tons per square mile per month in 1934 to 66.5 tons in 1944. This reduction in dirt of approximately one third of the amount deposited, is largely because of control of smoke in Chicago. Yet 66.5 tons of dirt falling on each square mile of the city's 210 sq. mi. area is still too high and demands more vigorous action on the part of the city and the active cooperation from all classes of fuel users, to effect a further substantial reduction.

Highway Construction

WHEN MOTOR TRANSPORTATION is again unlimited, highway construction will become a major industry. Governmental units, ranging from municipalities to the Federal Government, have already prepared extensive plans, and when construction becomes possible, the results of wartime research and experience will be available, says the Industrial Bulletin of Arthur D. Little, Inc. Research on composition of road surfaces, methods of laying road beds, design of cross sections, routing of highways and other allied problems is now conducted by a large number of independent agencies, with the National Research Council's Highway Research Board serving as a clearing house for new information and experience. As a result of the plans now being formulated, many authorities forsee more scientific treatment of all road construction and design problems.

BALDWIN *diesel engine*

capacities from....
150 to 1,050 horsepower



Something new has been added to diesel engine cylinder liners—a new process to lengthen cylinder liner life and give the engine greater reliability—more hours of continuous operation.

Chrome-plate, applied to cylinder liner bores, multiplies liner life 4 to 20 times, ring life 3 to 5 times, and reduces the risk of piston seizure.

All this adds up to more satisfactory service and lower maintenance cost for your Baldwin diesel.

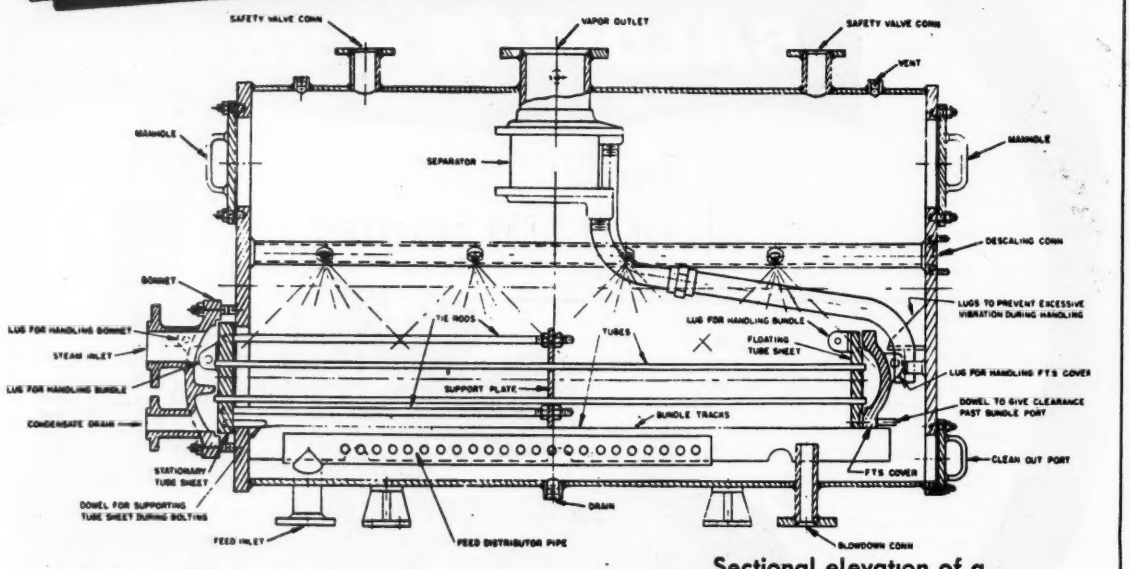
Baldwin 4-cycle diesel engines are serving railroad, marine, pipe line, power house and other industrial installations—capacities from 150 to 1,050 horsepower.

The Baldwin Locomotive Works, Locomotive & Ordnance Division, Philadelphia, Pennsylvania, U.S.A. Offices: Philadelphia, New York, Chicago, Washington, Boston, Cleveland, St. Louis, San Francisco, Houston.

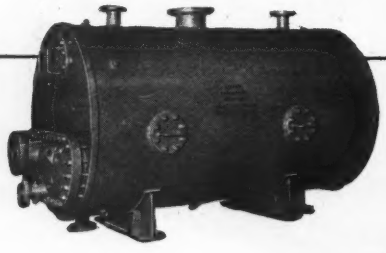
BLW THE BALDWIN GROUP

BALDWIN
DIESEL ENGINES

ADEQUATELY DESIGNED for Operation and Maintenance



Sectional elevation of a
Lummus Power Plant Evaporator



PURE WATER FROM ANY RAW OR SALT WATER SUPPLY

Lummus experience . . . in designing and fabricating power plant evaporators to meet individual requirements . . . is your guarantee of a dependable supply of pure water from any raw or salt water source.

Full-efficiency operation is assured by a soundly based design that provides adequate vapor separators and liberal, properly balanced disengaging areas. Easy maintenance is assured by a practical understanding of field conditions. All connections are readily accessible and do not require disassembly within the unit to remove the tube bundle.

Lummus engineering service is always available for the study of specific heat exchanger problems and equipment design to meet individual power plant conditions. For further information write to: The Lummus Company, 420 Lexington Avenue, New York 17, N. Y.

LUMMUS EQUIPMENT

SURFACE CONDENSERS
•
BAROMETRIC CONDENSERS
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STEAM JET AIR EJECTORS
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BLEEDER HEATERS
•
BOILER BLOWDOWN HEAT EXCHANGERS
•
EVAPORATORS
•
FUEL OIL HEATERS
•
LUBRICATING OIL COOLERS
•
STEAM JET REFRIGERATION

LUMMUS

HEAT EXCHANGERS

A Small Army of Specialists Keeps KELLOGG PIPING One Step Ahead in Performance

They work with one object in view; to produce piping which will successfully solve the most complicated design and operating problems.

Chemists, metallurgists, process and mechanical engineers do their part. When extremely complicated designs are encountered, super-sensitive apparatus, perfected by Kellogg for determining moments and forces electrically are put to use. Problems of plant size systems are solved in the laboratories before specifications are prepared.

The benefits of this comprehensive service are available to public utility, consulting, process and marine engineers. On your next difficult piping job, consult a KELLOGG engineer.

THE M. W. KELLOGG COMPANY

225 BROADWAY, NEW YORK 7, N. Y. • **JERSEY CITY, NEW JERSEY**

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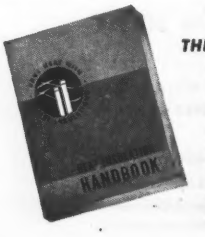
"Masterflex" Prefabricated Piping Systems • "Masterweld" pressure vessels for Power, Refinery and Chemical Industries. Heat Exchangers. Pyrolytic and Catalytic Cracking Units, Hydroforming, Reforming, Dehydrogenation, Alkylation, Desulphurization. Thermal and Catalytic Polymerization Units • JUIK Processes for Lubricating Oil Plants. Plastic Refractories • Radial Brick Chimneys.

"Defenders of Steam"

ORIGINAL LITHOGRAPH BY BENTON SPRUANCE

There is not a steam ship afloat, a power plant ashore, or a process industry anywhere that does not depend upon thermal insulations for its operation. In fact, the modern boiler and power plant could not function without the coverings that defend against heat loss and temperature drop. To exist, industry must insulate. • The work done by the men who make and the men who apply good insulations lives long after them. For example, countless pipe coverings and blocks of Ehret's 85% Magnesia that were applied before the turn of the last century are still doing 24-hour service today, with no end of their useful life in sight. This is a fact that is satisfying both to we who made them and to those who bought them.

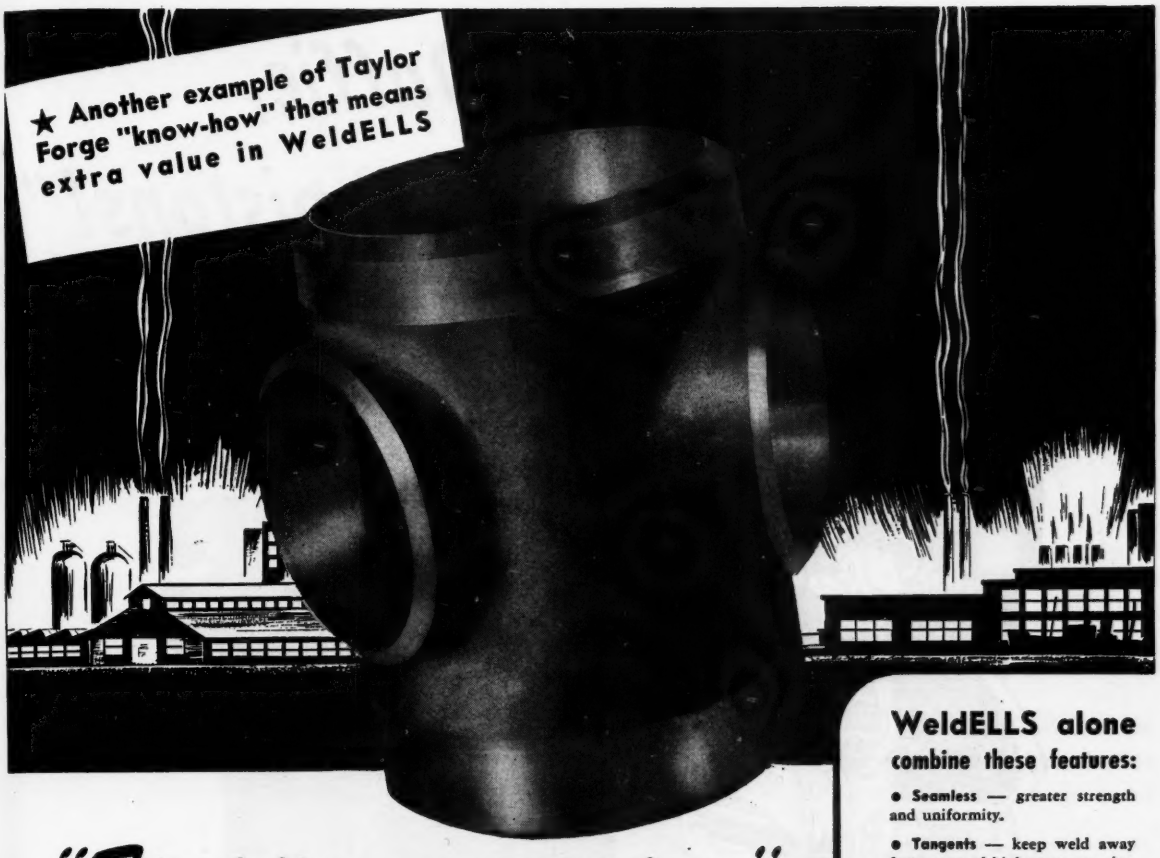


THE EHRET HEAT INSULATION HANDBOOK *contains a wealth of information on 85% Magnesia, Enduro high temperature and many other insulations—with selection and application data for boilers, piping and equipment. Fully illustrated, it includes heat loss and efficiency tables, specifications and recommendations for every temperature condition. A copy will be sent at your request.*

EHRET

MAGNESIA MANUFACTURING CO.

VALLEY FORGE • PENNSYLVANIA



"First time on any stage"

★ *As far as we know this is the only welding fitting of its kind. We forged it seamless in carbon-moly—10" pipe size in the run with .605" wall, and 7" in each branch with .429" walls.*

It is neither "fish nor fowl"—not a side outlet tee because the included angle between the outlets is only 120°, and it could hardly be called a cross. It's just one of the many once-in-a-life-time forging problems that have been assigned to us by engineers who have found that we do things with hot metal that no one else does.

YOU say you don't ever expect to run into a condition calling for a fitting like this? Probably not. But you do use standard welding fittings and this special fitting has a vital bearing on their selection. We have cited this and many other special forging problems because the "know-how" accumulated in solving them is the vital ingredient in every fitting in our regular production line of WeldELLS and other Taylor Forge fittings for pipe welding.

Every one of these many special problems has added something to our knowledge in a field where knowledge is all important. What else could explain the unduplicated combination of features found in WeldELLS . . . features like extra metal properly distributed where stresses are greatest . . . tangents . . . extremely accurate dimensions . . . and the many other features listed opposite?

What else, indeed, could have developed fittings of which it can be said:

WeldELLS have everything

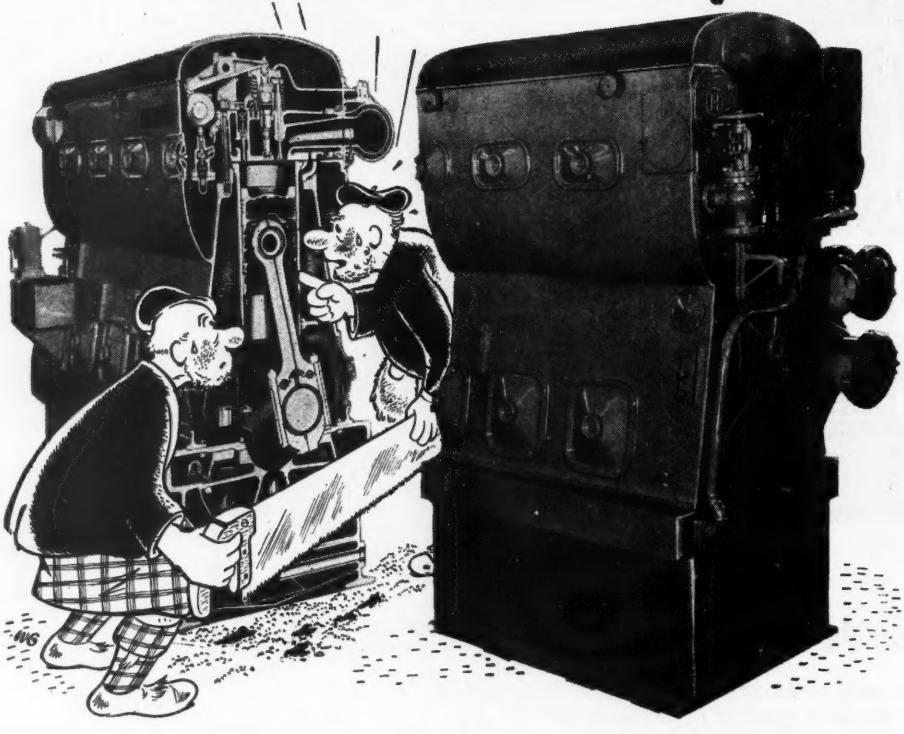
TAYLOR FORGE & PIPE WORKS, General Offices & Works: Chicago, P.O. Box 485

New York Office: 50 Church Street • Philadelphia Office: Broad Street Station Bldg.

WeldELLS alone combine these features:

- **Seamless** — greater strength and uniformity.
- **Tangents** — keep weld away from zone of highest stress—simplify lining up.
- **Precision quarter-marked ends**—simplify layout and help insure accuracy.
- **Selective reinforcement**—provides uniform strength.
- **Permanent and complete identification marking**—saves time and eliminates errors in shop and field.
- **Wall thickness never less than specification minimum** — assures full strength and long life.
- **Machine tool beveled ends** — provides best welding surface and accurate bevel and land.
- **The most complete line of Welding Fittings and Forged Steel Flanges in the World**—insures complete service and undivided responsibility.

"They'r-re richt, McDuffie, it HAS oil-cooled pistons!"



". . . thot's another-r-r reason this Diesel's sa thrifty." Oil cooling of pistons, McDuffie, reduces wear on rings and liners... lowers oil consumption... helps keep maintenance costs down.

Series 50 Diesels have advantages never before combined in a single design.

Besides oil-cooled pistons, they have overhead camshafts, unit pumps and fuel injectors, full pressure lubrication, and many other features. Now, for the first time, you can have the benefit of *all* these features in *one* tested and reliable Diesel. For a complete description, clip and mail the coupon today.

Joshua Hendy Iron Works, Sunnyvale, California.

Send for NEW Diesel Booklet—No Obligation

JOSHUA HENDY IRON WORKS
SUNNYVALE, CALIFORNIA

Mail me your new booklet that completely describes the Series 50 Diesel, with photographs and cross-section cutaway drawings showing the design of all parts.

Name_____ Position_____

Company or business_____

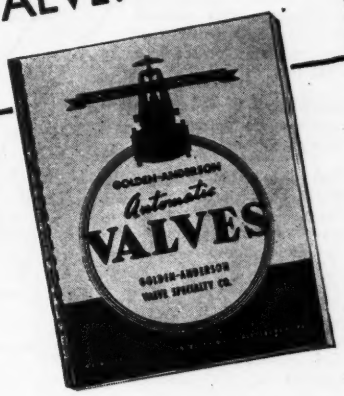
Address_____

I am interested in Marine ☐ Stationary ☐ models and in hp ranges from 190-250 ☐ from 250 up ☐

80-D-16

There's no chatter or spinning

WHEN YOU OPERATE THE GOLDEN-ANDERSON TRIPLE ACTING NON-RETURN VALVE!



Here is a valve that operates effectively . . . without banging, chatter or spinning . . . *under any flow conditions!* It's the "Double Corliss" dashpot assembly that does this cushioning job—and makes the GAVSCO Non-Return Valve reliable for any emergency. The design assures perfect alignment of moving parts and prevents galling or binding.

In operation the Non-Return Valve will:

1. **Automatically cut in a boiler whenever its pressure equals line-header pressure.**
2. **Isolate a boiler automatically whenever its pressure, from any cause, is lower than line-header pressure.**
3. **Prevent steam flow from boiler in event of sudden drop of line-header pressure below the boiler pressure by means of differential shot pilot valve.**

Get this unfailing, automatic life and property protection for *your* operations. The valve illustrated is a Toggle Yoke design, available in sizes from 2½" to 12", to handle 600 to 1500 lb. pressures. Other types we can supply include Angle, Globe, Elbow and Cross patterns. .

This catalog contains illustrations and detailed descriptions of all GAVSCO Specialty Valves. Write for your copy today. Get acquainted with this complete line of automatic valves!

GOLDEN-ANDERSON
VALVE SPECIALTY CO.
FULTON BLDG. PITTSBURGH, PENN.

WORLD'S BEST AUTOMATIC Valves

FOSTER REGULATION ENGINEERING*

MEANS THE RIGHT VALVE FOR

LONG LIFE AND EASY MAINTENANCE

FOSTER REGULATION ENGINEERING applies to valves of all types and capacities. Here's a small one, Type 39-Y3 for close regulation of small volumes of steam, air, water or oils. It is one of several Foster Y-types.

OPERATING FEATURES

Easier action because of exceptionally long, large diameter spring.

Pressure equalizes faster because the snubbing action of finger-type springs prevents overtravel of the disc.

Full effective area of the diaphragm is maintained through use of properly proportioned jamb nut.

Only small changes in reduced pressure are needed to overcome inlet pressure at orifice. Ratio of diaphragm area to orifice area is 150 to 1.

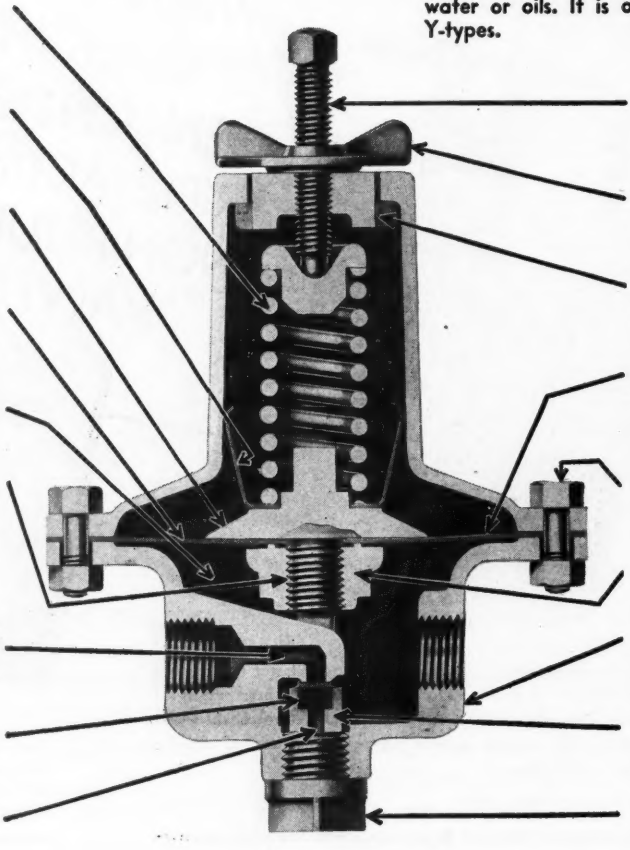
Regulation is closer because large chamber permits complete expansion.

High diaphragm pressures do not affect thread structure or joint tightness because of large diameter, rigid load screw.

Full satisfaction of downstream demand up to the capacity of the valve is obtained because of large area, smooth entrance port, assuring full inlet pressure at orifice seat.

Grit particles are absorbed by soft disc preventing damage to seat.

Disc always returns to same seating indenture because of guide pin.



MAINTENANCE FEATURES

Close adjustment of reduced pressure is easy because adjusting spring is long, with fine thread.

Once set, locknut assures constant compression of spring, regardless of line vibration.

Quick inspection or spring replacement because of removable bayonet-type head.

Diaphragm assembly with jamb nuts, yoke and disc can be removed as a unit for inspection without breaking center joint.

Quick dismantling at main joint because of easily replaced, standard bolts and nuts.

Diaphragm can be readily inspected or replaced. Yoke unscrews at center thread.

Sediment and scale can be removed without special tools because of open type body.

Hole provided in yoke makes it easy to drive out worn disc.

Seat may be inspected or resurfaced through bottom plug opening.

*** FOSTER REGULATION ENGINEERING MEANS**

(1) Intelligent understanding of the operator's problems.
(2) Thorough knowledge of performance characteristics necessary for selection of the right valve for the application.
(3) Sixty-six year's experience in design and manufacture of practical valves.

★ **SPEED THE DAY** ★
BUY MORE WAR BONDS

FOSTER ENGINEERING Company

PRESSURE REGULATORS...RELIEF AND BACK PRESSURE VALVES...AUTOMATIC STOP AND CHECK VALVES...ALTITUDE VALVES...DAMPER REGULATORS...FAN ENGINE REGULATORS... PUMP GOVERNORS...TEMPERATURE REGULATORS...LIQUID LEVEL CONTROLLERS...FLOAT AND LEVER BALANCED VALVES...NON-RETURN AND TRIPLE DUTY VALVES...VACUUM REGULATORS OR BREAKERS...SIGHT FLOW BOXES...STRAINERS...SAFETY VALVES...SIRENS

4-FE-3

111 MONROE STREET • NEWARK 1, N. J.

Maintenance time reduced to a minimum

Every day, Powell Valves are piling up records for continuous operation without requiring maintenance. And when they finally need attention, Powell design and construction is such that the time spent in maintenance is reduced to a minimum. The gate valves shown here are examples of the complete Powell Line in which ease of maintenance is always a feature.

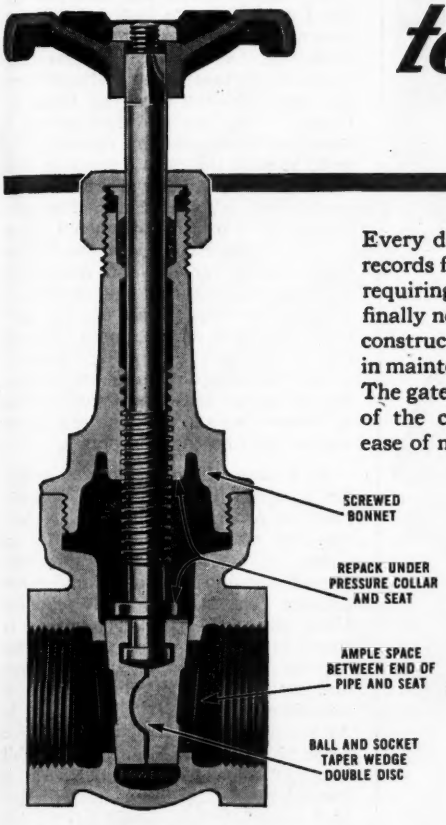

SCREWED BONNET
REPACK UNDER PRESSURE COLLAR AND SEAT
AMPLE SPACE BETWEEN END OF PIPE AND SEAT
BALL AND SOCKET TAPER WEDGE DOUBLE DISC

Fig. 500
BRONZE "U. S." GATE VALVE

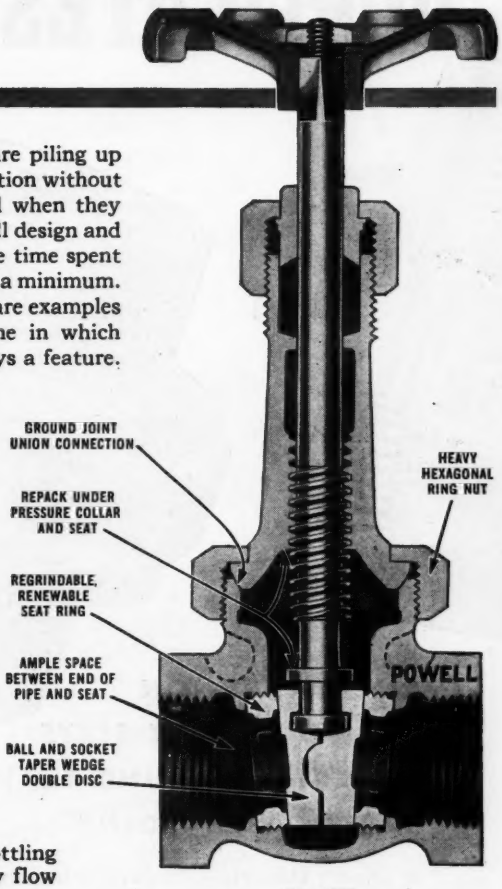

GROUND JOINT UNION CONNECTION
REPACK UNDER PRESSURE COLLAR AND SEAT
REGRINDABLE, RENEWABLE SEAT RING
AMPLE SPACE BETWEEN END OF PIPE AND SEAT
BALL AND SOCKET TAPER WEDGE DOUBLE DISC
HEAVY HEXAGONAL RING NUT
POWELL

Fig. 1375
BRONZE "WHITE STAR" GATE VALVE

In all installations where pressure drop is undesirable and throttling is unnecessary, the gate type of valve, with its full straightway flow area through the body, should be used.

Fig. 500 is Powell's answer to the widespread demand for a sturdy small bronze gate valve where initial cost is a consideration. With its readily removable screwed-in bonnet it is easy to reface the seats and disc or replace the disc if necessary. The taper wedge double disc, with its Powell-designed ball and socket action, readily adjusts itself to any inclination of the seat faces caused by refacing, thus effecting a tight closure. Since the seats are cast integral with the body, this valve will give dependable service as long as sufficient metal remains in the seats to permit refacing.

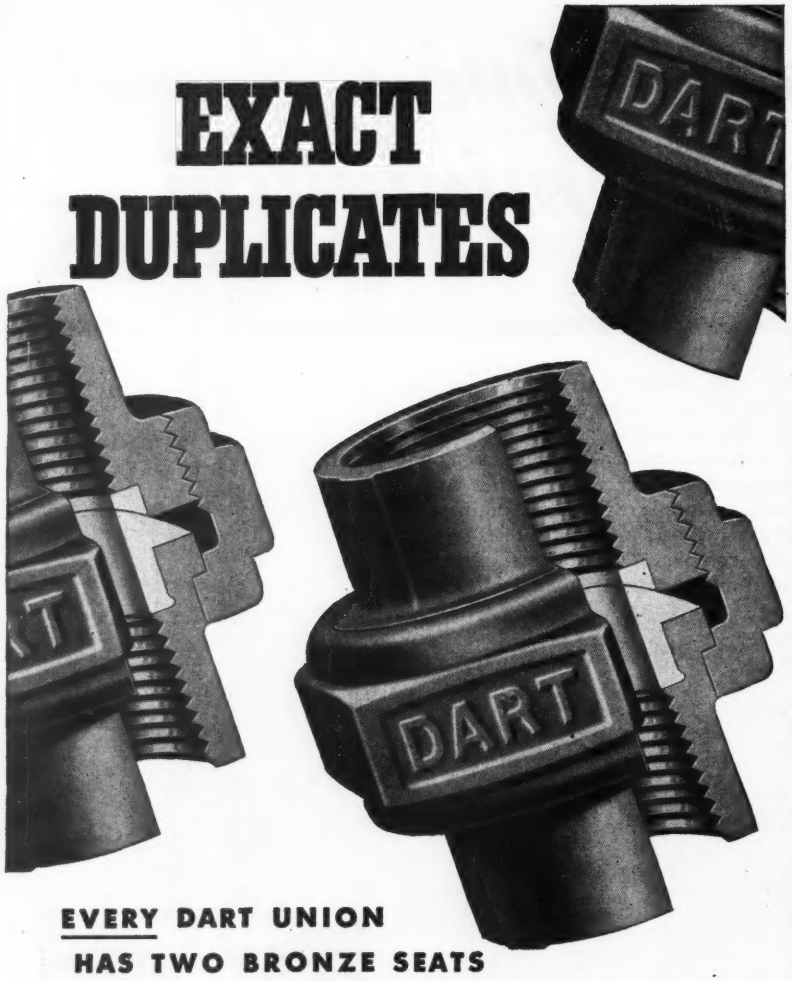
For *extra long life,* Fig. 1375 is recommended. The ground joint union connection makes it especially easy to remove the bonnet assembly from the body to reface or, if necessary, to replace the disc and renewable seats. This may be done any number of times without any distortion of the body neck, such as might occur with a screwed-in bonnet. Both disc and seats are made from a special hard nickel-bronze alloy which resists wear over a long period of time. When these parts will not take further refacing, they can be readily replaced with new ones, thus greatly prolonging the life of this valve.

All Powell Valves that require repacking are provided with a specially machined cut-off to permit repacking under pressure when wide open.

The Wm. Powell Co.
Dependable Valves Since 1846
Cincinnati 22, Ohio

POWELL VALVES

EXACT DUPLICATES



EVERY DART UNION
HAS TWO BRONZE SEATS
PERFECTLY GROUND TO FORM
A TRUE BALL JOINT

Every Dart closes to form a leak-proof, true ball joint. *Every* Dart will keep this perfect seat indefinitely, yet be ready to move instantly whenever you have a new job for it.

Dart bodies and nuts are made of high-test air refined malleable iron—are practically unbreakable. That is why economy-wise buyers *standardize* on Darts.

DART
UNIONS

E. M. DART MANUFACTURING CO. PROVIDENCE, R. I.

America Gave Me Opportunity

(Continued from page 64)

Yes, America has the laboratories. But I don't mean to imply that these laboratories are any better than those elsewhere. On the whole, engineering research equipment and methods here are generally the same as those in France. The labs and test stands I have seen in this country resemble far more closely the ones I used in Europe than an American kitchen resembles a kitchen in Paris. The first laboratory I worked in when I came to the United States was the Diesel engine lab at Pennsylvania State College. It wasn't better equipped than, say, the mechanics lab of the Sorbonne in Paris where I once studied. But there is this important difference. In the United States there are a number of college labs like Penn State's, in France there is only one university engine lab like the Sorbonne's.

As I have already said, the credit for making this difference possible goes to American Industry. A factory the size of Clark Bros. Co., in Olean, N. Y., where I am now employed, would in almost any other country content itself with plodding along old and well-tried paths. It would be satisfied to shop around for patents as a means of buying success and never dream of investing in an experimental department. But in America, through industry-sponsored research, anything that looks as if it might work gets a chance. And it doesn't make any difference whether that thing is a new-fangled electronic device for testing engines, a book-long mathematical calculation—or a girl.

People listen to what you have to say, even when it is said in the kind of English you learn in European high schools. They're willing to accept you for what you're worth. They'll give you a chance just because you asked for a chance, and might work out all right and they won't laugh at your mistakes in English. This sort of an attitude makes for friendliness and teamwork and the kind of easy efficiency with which this country has met its war demands. But most important, it makes for an atmosphere in which failure is less feared than stagnation, which is particularly favorable to constructive work.

My story isn't exceptional. The things that happened to me could have happened to anybody—American or foreigner. And it wasn't because chance took me to Penn State or to Clark Bros. It would have been the same—as you Americans would put it—at Podunk Normal or at Gadget, Inc. The places I speak of I speak of because they are familiar, but the magic thing I found there can be found all over America. And that is opportunity.

For Cooling—

- LUBRICATING OIL
- TRANSFORMER OIL
- DIESEL JACKET WATER
- CIRCULATING WATER
- WASTE LIQUORS

ONE OF A SERIES OF ADVERTISEMENTS DESCRIBING THE MANY TYPES OF G-R HEAT TRANSFER APPARATUS

THE G-R MULTIWHIRL COOLER

The important advantages of the G-R Multiwhirl Cooler for cooling . . . for heat recovery . . . for heat transfer . . . on many liquid services have been proven in thousands of installations.

Some of these advantages: MINIMUM PRESSURE DROP . . . because of the correctly proportioned baffle system. MULTIPLE CONVENIENCES . . . because of the ease of installation, inspection, and cleaning. LASTINGLY SATISFACTORY SERVICE . . . because of freedom from expansion and contraction strains and provisions against leakage.

If your power-generating equipment or plant processes require cooling of liquids, be sure to investigate the G-R Multiwhirl Cooler. Write for Bulletin 710 describing these units in detail.

G-R BUILDS ALL THESE UNITS FOR HEAT TRANSFER SERVICE . . .

- Evaporators
- Stage Heaters
- Gas Coolers
- Drain Coolers
- Aftercoolers
- Air Preheaters
- Fuel Oil Heaters
- Jacket Water Coolers
- Process Heat Exchangers
- Transformer Oil Coolers
- Generator Air Coolers
- Lubricating Oil Coolers
- Storage Tank Oil Heaters

THE GRISCOM RUSSELL CO.
285 Madison Ave., New York 17, N. Y.

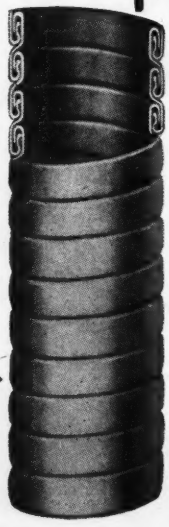
GRISCOM-RUSSELL
Pioneers in Heat Transfer Apparatus

REX-TUBE

Top choice for tough jobs!

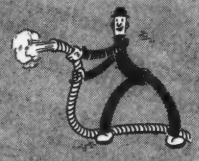
● Put REX-TUBE type RT-15 on your tough, hard-to-handle connection problems. Then watch what happens when this rugged, high-quality flexible metal hose takes charge of the heavy-duty assignments! You can forget all about frequent replacements—costly delays. For RT-15 is famous for its ability to take punishment; to keep right on outperforming and outlasting many other types of hose under the roughest usage you can give it.

There are ample reasons why production men choose REX-TUBE type RT-15 when it comes to taking hard knocks. Illustrated below are just a few of RT-15's many outstanding features. Write us today and ask for Booklet E-144.



REX-TUBE (RT-15)—is strong and well-constructed to take years of wear and tear. Made from heavy strip, steel or bronze. Interlocked design, with inner packing of high-grade asbestos.

REX-TUBE (RT-15)—is widely used for handling steam at low and moderate pressures, for unloading and loading tankers and barges, steaming out tank cars, and other "hot" process jobs.



REX-TUBE—is part of the big, complete C.M.H. family of Flexible Metal Hose. RT-15 is only one type in the REX-TUBE line. There are other REX-TUBE types, in various sizes, with soldered or packed-on couplings, to meet practically any industrial requirement.

Flexible Metal Hose for Every Industrial Use

ARMY E NAVY

CMH CHICAGO METAL HOSE CORPORATION

MAYWOOD, ILLINOIS

Plants: Maywood and Elgin, Ill.

NEW EQUIPMENT

Information that you desire about any equipment will be gladly furnished without obligation. Write to POWER PLANT ENGINEERING 53 W. Jackson Blvd., Chicago 4, Ill.

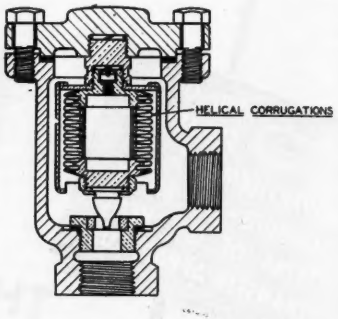
Steam Traps

SARCO CO., INC., 475 Fifth Avenue, New York 17, N. Y., has announced successful manufacture of bellows from heavy wall bronze tubing drawn and helically corrugated in its own plant by methods developed by the Company.

These have made possible the introduction of an entirely new line of thermostatic steam traps, for pressures up to 225 psi using single, large diameter bellows, for inlet sizes ½ to 2-in. inclusive, and with capacities double those of the Company's No. 9 series.

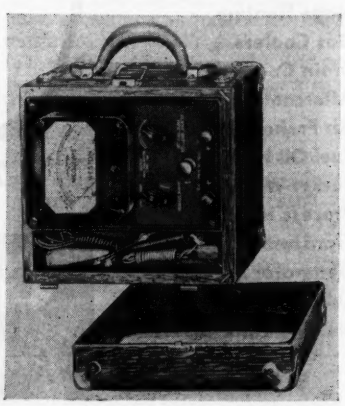
The new traps are available in two pressure ranges, No. 9-100 for pressures 0 to 100 psi and No. 9-225 for pressures 0 to 225 psi.

The construction is indicated in the illustration. The heavy wall bellows is screwed into the end closures and the joints are sealed by brazing, using the latest electronic induction heating equipment.



Insulation Tester

WESTON ELECTRICAL INSTRUMENT CORP., 617 Frelinghuysen Avenue, Newark 5, N. J., has announced a compact, direct-reading insulation tester, known as Model 796, which provides complete insulation and resistance tests up to 200 megohms at a test potential of 350 to 500 v d-c. This instrument eliminates the necessity for crank turning. Leakage tests can readily be made in cramped quarters or other hard-to-get-at places,



LADISH *Controlled Quality* Fittings

For pipe lines, power plants, refineries and ships—where dependability is essential to pressure piping efficiency—Ladish Forged Steel Fittings reduce maintenance expense and safeguard against costly breakdowns.

Produced under exacting metallurgical controls and rigid standards of craftsmanship, Ladish Fittings bear the authentic symbol of Controlled Quality identification—the Ladish Heat Code.

ARMY E NAVY

FITTINGS DIVISION

TO MARK PROGRESS

LADISH DROP FORGE CO.

CUDAHY • WISCONSIN

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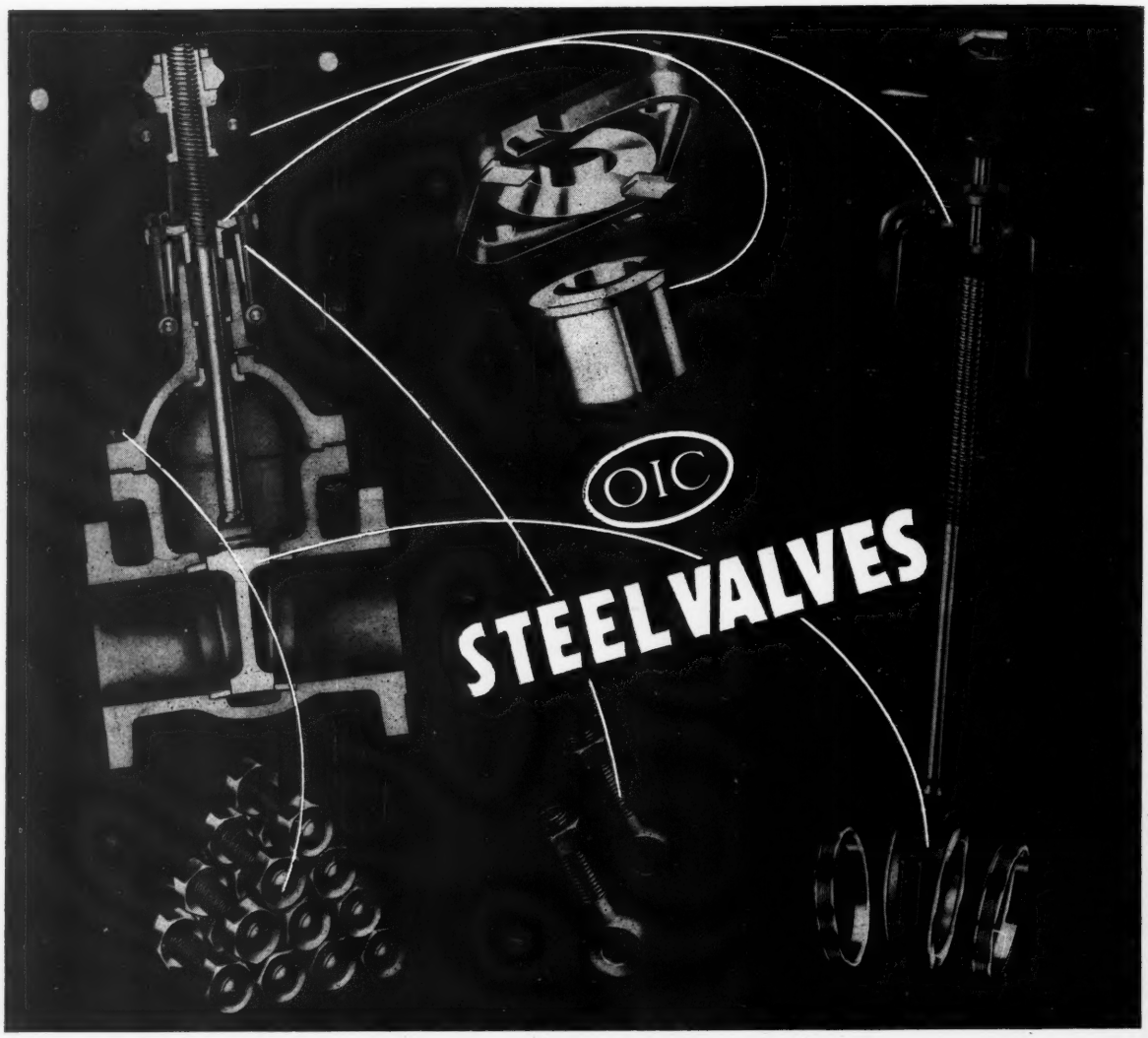
District Offices: Lincoln Bldg., New York City • Rockefeller Bldg., Cleveland • Peoples Gas Bldg., Pittsburgh • Sterling Bldg., Houston • Petroleum Bldg., Los Angeles



MATCHING the superior qualities of OIC Bronze and Iron Valves that have been outstanding for more than 60 years, OIC Cast Steel Valves are in pace with today's emergency demands . . . filling a definite need wherever steel valves are required.

Combining time-proved features with tested modern refinements, they equal and exceed the quality and performance standards set by the principal users' and manufacturers' specifications.

OIC Cast Steel O.S. & Y. Gate Valves are built to control fluid flow dependably and absolutely. They are contributing vitally to the efficient operation of:

Petroleum Refineries
Oil & Gas Pipe Lines
Central Power Generating Plants
Industrial Power Units
General Industrial Processes

OIC Steel Gate Valves* are regularly available in trims suitable for oil, oil vapor, steam, water, gas or air service over a broad range of pressures and temperatures. Valves with trims for other services available on special order.

There is an OIC Distributor near you, ready to demonstrate to you the many superior features of OIC Cast Steel Valves. Call him . . . or write to us for details.

***Also available are companion OIC Steel Globe, Angle and Swing Check Valves.**

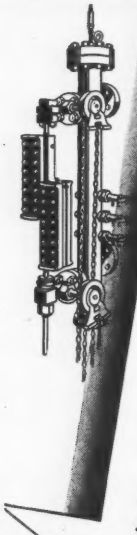
ARMY E NAVY
OIC

THE OHIO INJECTOR COMPANY
WADSWORTH, OHIO
Quality Leaders in Valve Manufacture Since 1883

CORRUGATED PIPE
AND BENDS
ADAPTABLE • LESS STRESS • SAVED SPACE
In problems involving high forces or moments due to thermal expansion, Navco Corrugated Pipe and Bends are frequently the only solution.
By reducing the bending stresses and minimizing the end reactions, a safe design is insured which perhaps could not otherwise be obtained.
Whenever you have any unusual Piping problems, consult Navco.
NATIONAL VALVE & MFG. CO., PITTSBURGH, PA.
ATLANTA BOSTON BUFFALO CLEVELAND CHICAGO NEW YORK PHILADELPHIA
NAVCO
NAVCO PIPING

Double Check

OVERHEAD GAGE READINGS WITH THE YARWAY EYE-LEVEL INDICATOR



Here is a success story you will want to know about. Publicly announced only six months ago (after accelerated service tests had duplicated more than 50 years of normal boiler-room operation) purchases of this instrument already number more than 2,000. Why this quick acceptance? Read what steam engineers and plant operators say about it.

"At last—a really accurate means of reading boiler water levels, right in front of your eyes. No more squinting, stretching or guessing."

"We use them on the instrument panel and in rear of boiler as well. When blowing down, they are an indispensable aid in keeping constant check on boiler water levels."

"An indicator you can always see—even in the dark. Unaffected by discoloration of gage glasses or by positional relation to overhead gage."

"Shows water level beyond range of gage and always indicates high or low—even when full or empty gages both look the same."

Yes, this unique boiler water level indicator is operated by the boiler water itself, using the pressure differential between a constant head of water and the varying head of water in the boiler drum. It offers accuracy and convenience never before possible.

Its indicating mechanism is never under pressure. Its action is instant, constant, frictionless. There are no stuffing boxes. Mechanism is perfectly balanced on jewelled bearings outside of the pressure chamber. It is suitable for all pressures up to 1500 lbs.

Write for Bulletin WG-1820.

YARNALL-WARING CO. 114 Mermaid Ave., Phila. 18, Pa.

Ask about the new Yarway color and sound motion picture, available for group showings.

YARWAY REMOTE LIQUID LEVEL INDICATOR

the operator always having complete freedom of both hands.

Although the test potential is 500 v at the terminals, the current is only a few microamperes thus making it impossible for the operator under normal conditions to receive any harmful shock.

This new insulation tester operates from self-contained, long-life lightweight batteries. The overall size is only 8 by 8⅝ by 9-in., and weigh but 15 lb. It also can be used for general resistance measurements from 10,000 ohms to 200 megohms.

Square Flax Packing

DEVELOPMENT OF Palmetto Square Flax Packing which is made by a method not heretofore used in manufacturing flax packing, has been announced by Greene, Tweed & Co., Bronx Blvd. at 238th St., New York 66, N. Y.

Until the advent of Palmetto Flax Packing it has been the custom to plait dry flax rovings to packing size and then immerse the plaited packing in a bath of hot tallow and depend upon the packing to absorb the lubricant. Results frequently left something to be desired and it is a recognized fact that flax so made usually became hard in service.

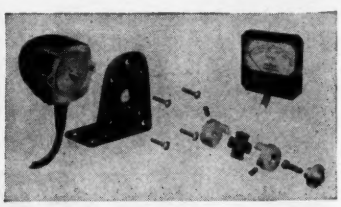
In the manufacture of Palmetto Square Flax Packing each single strand of flax roving is put through a machine which forces high grade tallow under heat and pressure into the core of each strand of flax. After the flax strands are individually lubricated they are plaited to make finished packing. Since each strand is separately lubricated, it will remain soft and pliable for long periods of time and the finished packing will resist hardening.

This is available in regular form or in the graphited style sometimes called Waterproof Hydraulic Flax.

Electric Speed Indicator

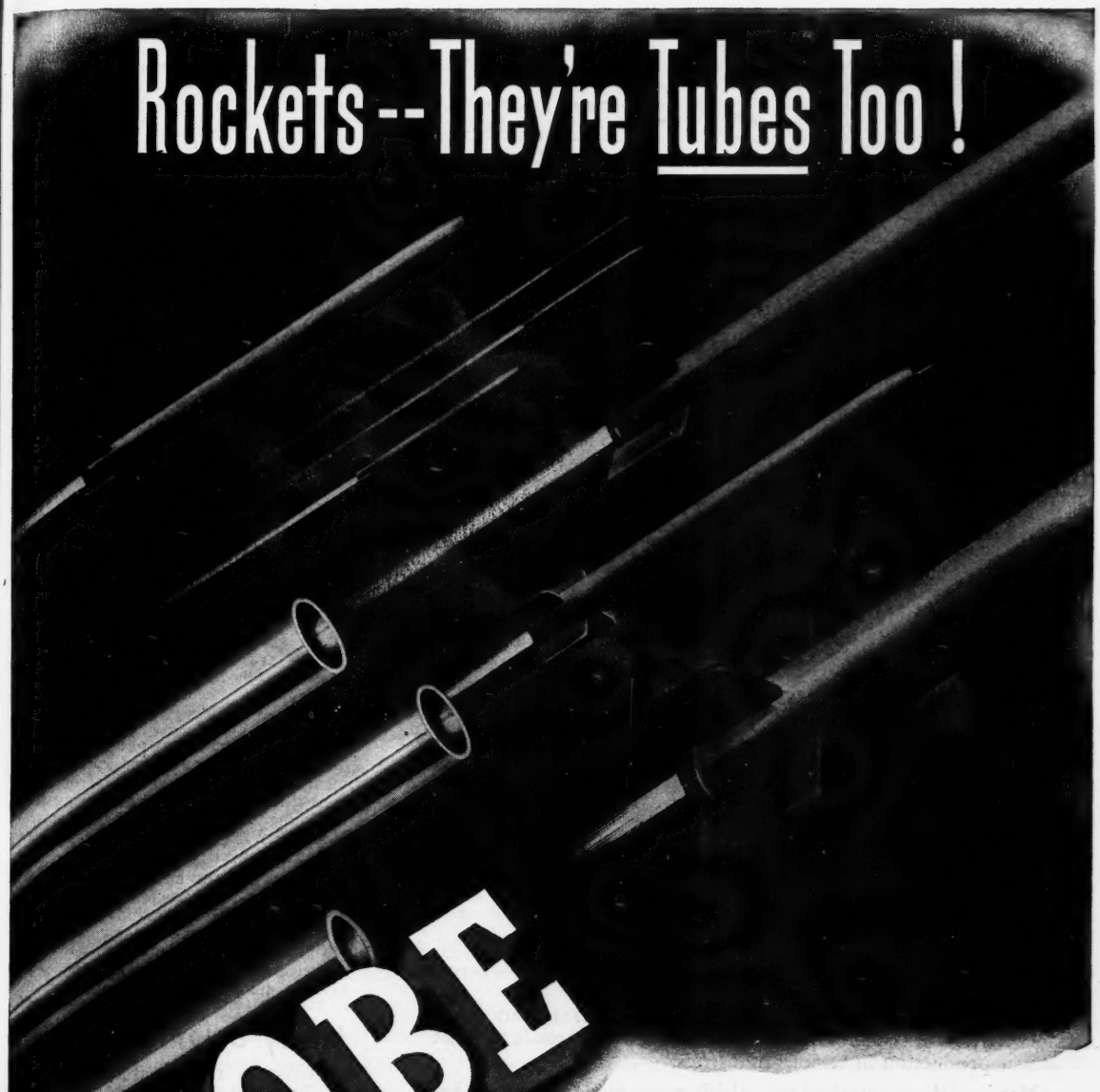
A STURDY, ACCURATE, low-cost electric speed indicator, developed by the Reliance Electric & Engineering Co., Cleveland, makes it possible to determine and to set proper operating speeds in a broad new field of applications, where the installation of such instruments was heretofore not economically feasible.

The Reliance Electric speed indicator, which gives accurate readings of speeds from 100 rpm to 5000 rpm, consists of two units. The pick-up unit, a miniature six-pole alternator with a permanent magnet rotor, is mounted on the shaft whose speed is to be measured.



The indicator, a permanent magnet, moving-coil type, meters the pick-up output on a 3¼-in. scale which cover 95 deg of arc. The resistance of the indicator has been made sufficiently high, so that the size or length of the leads connecting the units will have no effect on accuracy, and the indicator may be located at any distance from the pick-up

Rockets -- They're Tubes Too !



AN interesting and dramatic example of the versatility and adaptability of seamless steel tubing is the rocket — formidable weapon of modern war. The body or cylinder of the rocket is a section of seamless steel tubing specially shaped and formed.

Many of the most challenging needs of war equipment and materiel have been met by steel tubes. If your present or future production plans call for tubing — mechanical, pressure, stainless — check with us as a specialized source of supply. The uniformity and quality of Globe Steel Tubes are widely recognized.

★ Pressure Tubes
★ Mechanical Tubing
★ Condenser & Heat Exchanger Tubes
★ Seamless Stainless Steel Tubes
★ Gloweld Welded Stainless Steel Tubes
★ Globeiron High Purity Iron Seamless Tubes

5017

GLOBE TUBES

GLOBE STEEL TUBES CO. • MILWAUKEE 4, WIS., U.S.A.

"BALANCED WET BULB" TEMPERATURE CONTROL

U. S. Patent Re-Issue No. 22,533

CONTROL OF TEMPERATURE IN LIQUIDS and GASES

HELPS INCREASE PRODUCTION

U. S. Patent Nos. 2,296,946 and 2,321,933. Re-Issue No. 22,553—Other Patents Pending.

● During the first year of the war, hundreds of installations of the NIAGARA AERO HEAT EXCHANGER were made to assist in war production in various industries.

Many of these installations, which were made primarily because they offered the advantage of saving the cost of cooling water, now show an extra value of great importance in increasing plant production.

Production is increased in three ways: (1) By preventing rejections (2) By permitting quicker starting of every production batch at the correct temperature (3) Your production is faster, due to your *constant* temperature.

Write for illustrated Bulletin No. 96.

NIAGARA BLOWER COMPANY

Over 30 Years of Service in Industrial Air Engineering

DEPT. PP-45 6 E. 45th St. NEW YORK 17, N. Y.

Field Engineering Offices in Principal Cities

INDUSTRIAL COOLING HEATING • DRYING

NIAGARA

HUMIDIFYING • AIR ENGINEERING EQUIPMENT

unit. The indicator is not affected by other magnetic material, and there is no loss of accuracy due to length of service.

Instantaneous and continuous speed indication is independent of the direction of rotation of the shaft. Pick-up windings are stationary, and there are no commutators or slip rings. No conduits are required, and lifetime lubrication further simplifies maintenance.

Indicators are provided for full-scale deflection corresponding to 1500, 2000, 2500, 3000, and 5000 rpm, and special scales are available to read in other units, such as feet per minute, and process cycles of varying times.

Light Weight Electrode Holder

A NEW light weight, low cost holder for welding electrodes has been announced by The Lincoln Electric Co., Cleveland, Ohio. Having a current rating of 300 amp with ample capacity for overload, the new holder will handle various sizes of electrodes ranging from 1/16-in. diameter to 1/4-in. diameter inclusive.

Jaws, made of high conducting and wear resisting copper alloy known as "Lincalloy," will withstand rough treatment and are fully guarded from contacting the work by durable spring steel insulating guard that is easily replaceable. The trigger of the holder is of molded, heat-resisting inorganic material.

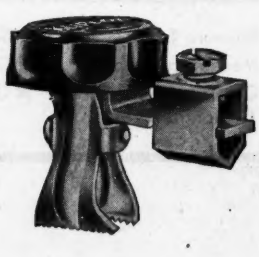
Other features include: hollow, air-cooled, heat-resisting fibre handle; excellent balance and equally good performance on both alternating and direct current. The holder is designed to hold the electrode securely at any angle yet permits quick and easy change of rods.

Heavy Duty Test Clamps

THIS NEW TEST clamp line, developed by Trico Fuse Mfg. Co., 2948 North 5th St., Milwaukee 12, Wis., employs jack-screw gripping action and is recommended for making heavy duty temporary connections; motor and meter testing, jumpers, cable and bus-bar taps, battery charging, welding, and many other shop and laboratory purposes.

A slight twist of the finger-tip safety knob exerts pressure, supplying carrying capacity of 20 to 350 amp on constant and intermittent duty.

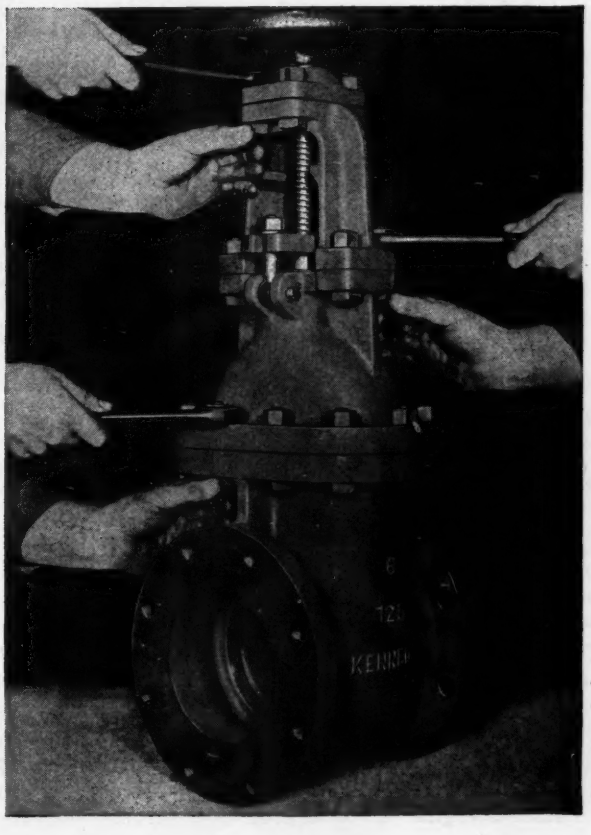
Solderless lugs provide good contact and quick electrical connections without the use of special tools or cutting into wire; arranged to swivel around



"Trifles make perfection but perfection is no trifle"

NUTS and BOLTS that never balk

One of a series of advertisements explaining how Kennedy gives careful attention to the details of valve design, construction and workmanship that provide maximum effectiveness, convenience, and length of service.



Rust-proofed gland bolts and nuts to prevent corrosion . . . all bolts with nuts on top of flanges for convenience . . . all nuts accessible to open-end wrenches . . . slotted stuffing box bolts that swing out of the way for repacking, with washer-type nuts that prevent loss of washers . . . these are some of the reasons why you never need fear balky nuts and bolts on this Kennedy Standard Iron Body Wedge Gate Valve.

Small items? Not to the engineer who has experienced the many little annoyances that are sometimes encountered in handling valves and who wants the best for his money. Moreover, these details typify the care and attention given to every part, large or small, of Kennedy "Extra Value" Valves—obtainable at no extra cost to you.

THE KENNEDY VALVE MFG. CO.

ELMIRA • NEW YORK

KENNEDY *valves . . . pipe fittings . . . fire hydrants*

THIS IS THE BRIGGS CLARIFIER...
that guards the Cooper-Bessemer Diesel...
that drives the 1850 cu. ft. compressor...
that powers the tools of
Sun shipbuilders who build ships
to supply
our fighters overseas
Briggs

For over 18 months this Briggs Lube Oil Clarifier has protected this most important piece of equipment at the Sun Shipbuilding and Drydock Company, Chester, Pa.

Operated 100 days a year at 100% operating load . . . moving parts of the engine show no visible signs of wear since the Briggs Oil Clarifier was installed. Refills and oil are changed at 2000 hours . . . and it is not even necessary to clean the lube oil system when putting in new oil.

Such dependability and time-saving help the Sun Shipbuilding and Drydock Company, "keep 'em sliding down the ways."

Wherever equipment breakdown would interrupt production—**THERE'S THE PLACE TO INSTALL A BRIGGS OIL CLARIFIER!** Available in both lube oil and fuel oil models—for every size and type internal combustion engine—for hydraulic oils, turbine oils, etc.

A Briggs distributor will tell you **WHY** and **HOW** Briggs Oil Clarifiers save money, protect equipment, eliminate loss of valuable man hours. Call him—he's listed in the "Filter" section of your classified telephone directory. Or—write direct for literature.

Briggs
PIONEERS IN MODERN OIL FILTRATION

BRIGGS CLARIFIER COMPANY **WASHINGTON 7, D. C.**

BRIGGS FULLERS EARTH TYPE CARTRIDGES GIVE YOU 3 TIME —3 WAY FILTRATION—Remove invisible as well as visible contaminants—maintain oil in "refinery-pure" condition.

BRIGGS DISCEL (All-Cellulose Type) CARTRIDGES are manufactured of specially-processed cellulose for effective filtration of additive-type oils.

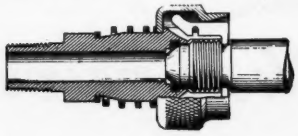
clamp, permitting wires and cables to hang in a natural position after installation.

Available in six sizes to fit across ferrule and knife blade fuse clips, switch blades, round or flat bus-bars and cables.

New Direct-Connect Coupling

THE E. B. WIGGINS OIL TOOL CO., INC., 3424 E. Olympic Blvd., Los Angeles 23, Calif., announces development of a new direct-connect coupling, specially adapted for use in testing operations.

The coupling is specially designed for use in all testing operations. The new coupling fits over the end of any standard type nipple, the dogs of the coupling

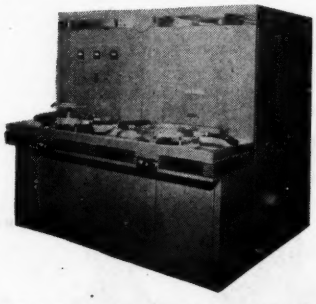


gripping securely in the undercut just behind the threads of the nipple. Connecting any fluid or air line with the coupling takes only a second.

Wiggins new direct-connect coupling is specially adapted for use in testing operations. It affords countless applications to manufacturers of carburetors, aircraft, automobile, refrigeration and air conditioning equipment, also metering gages and valve gages and hydraulic equipment. These couplings come in sizes of ¼, 5/16, ⅜, ½, ⅝ and ¾ in.

Electronic Heater

INDUSTRIAL HEATING DIVISION of the General Electric Co. has recently developed a new 50-kw electronic heater for surface and localized hardening of gears, rods, and other parts and for annealing, brazing, and soldering operations. The new heater incorporates all of the important features of the 5-kw and 15-kw G-E heaters and, in addition, is capable of heat-treating much larger parts or the same size parts in less time. This heater is readily applicable for many different heating jobs merely by changing the induction-coil fixture.



This heater is available in models rated either 230 or 460 v, 3 phase, 60 cycles. In operation, the parts to be heated are positioned in the fixture, and the Start button is pressed. Automatic controls then regulate the heating and quenching cycles, assuring duplication of results on each part. An attached work table provides two heating positions, permitting full utilization of the high-frequency power supply to secure maximum production.

Where conditions of service call for STEEL

. . . in the low pressure range where high temperature, corrosive liquids, fire hazards or need for unusual precaution against leakage or line strains make iron valves impractical—that's where **R-P&C** 150 lb. steel valves and fittings serve best.

READING-PRATT & CADY is especially well-equipped to make these valves, having long specialized on pressure castings of electric furnace steel. Beyond that, **R-P&C** rigid control—from drawing board to final test—assures you of maximum service from every **READING-PRATT & CADY** valve.

The line is extensive, including globes, angles, gates and checks in all the standard pressure classes from 150 lbs. to 1500 lbs.

We suggest that you get a recommendation from **R-P&C** the next time you need valves.

R-P&C offers you a single responsible source for bronze, iron and steel gate, globe, angle and check valves—cocks and lubrotite gate valves—bar stock valves—cast steel fittings—D'Este Automatic Valves and Engineering Specialties.

• Valves illustrated are flanged end. All are available with welding end—most with screwed end.

READING-PRATT & CADY

MANUFACTURERS OF
READING CAST STEEL VALVES AND FITTINGS • PRATT & CADY BRASS AND IRON VALVES
D'ESTE VALVE AND ENGINEERING SPECIALTIES

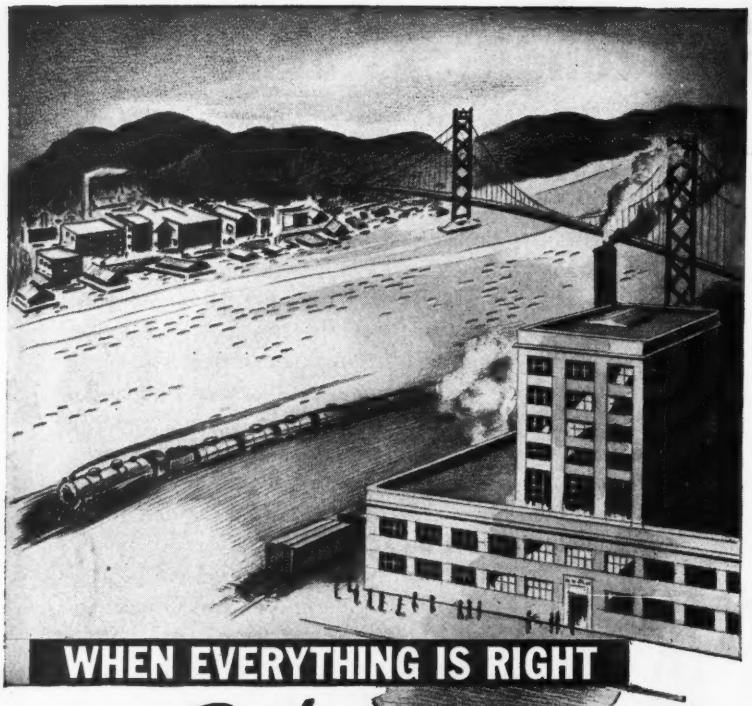
Reading, Pa. • Atlanta • Boston • Chicago • Denver • Houston • Los Angeles • New York • Philadelphia • Pittsburgh • San Francisco • Bridgeport, Conn.

READING-PRATT & CADY DIVISION
AMERICAN CHAIN & CABLE

ACCO

TRADE MARK

In Business for Your Safety



Often a new plant site is ideal from every angle—except the water supply. Whether required for cooling, process or drinking purposes, however, the bacterial quality of the *raw water* need not occasion abandonment of the location.

W&T engineered chlorination is demonstrating daily that objectional microorganisms—slime forms, iron bacteria, pathogens—can be destroyed, and their recurrence in the system prevented, economically and conveniently. The generally low and finely controlled chlorine residuals required have no deleterious effect on the water system itself, and, when properly specified, do not interfere with even such delicate chemical processes as the production of today's synthetics.

If you are in doubt about the water supply at a new location, or *if you are experiencing biofouling troubles at your present location,* Wallace & Tiernan Engineers will gladly make recommendations from their broad experience in industrial water treatment. CD-13

WALLACE & TIERNAN PRODUCTS, INC.

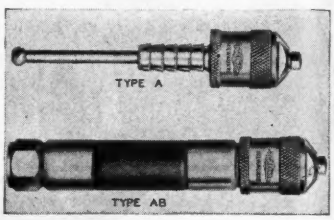
Manufacturers of Chlorine and Ammonia Control Apparatus

Belleville 9, New Jersey **Represented in Principal Cities**

The entire unit weighs approximately 6000 lb and is 84-in. wide, 94-in. deep, and 82-in. high over-all, completely enclosed in grounded steel, which minimizes radiation and affords protection for the operator. The electronic heater cabinet is composed of two compartments, one of which contains an air-cooled transformer to step-up power supply voltage to the six rectifier tubes, and such accessory items as a contactor, a tap-changing switch, and filament transformers. The other compartment contains the high frequency components—a single water-cooled oscillator tube and a bank of water-cooled capacitors. The two compartments are separated by a heavy, protecting partition. Meters and controls are conveniently mounted on the front of the two compartments, which are securely bolted together.

Air Guns

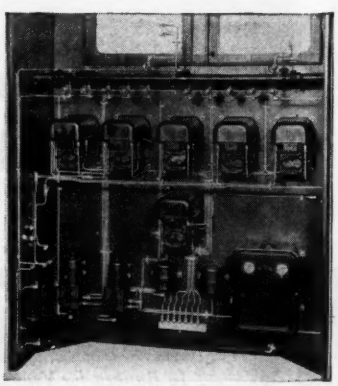
TRICO FUSE MFG. CO., 2948 North 5th St., Milwaukee 12, Wis., has announced a new line of air guns, for blowing purposes and operating air-driven tools, such as air vises, clamps, chucks.



A slight flex of the hose discharges a small puff or full blast of air as desired. Operation is instant and positive. The ball and socket valve joint has only two moving parts. Air pressure helps close valve tightly when fingertip pressure is released. Available in three styles and for complete range of hose diameters.

Prefabricated Control Panel

BAILEY METER CO., Cleveland 10, Ohio, is now in position to supply prefabricated boiler control panels which include all necessary connecting piping and electrical wiring for the operation of metering equipment and boiler control systems. These panels which are factory fabricated and



COPPER ALLOY BULLETIN

MARINE AND POWER EDITION

REPORTING NEWS AND TECHNICAL DEVELOPMENTS OF COPPER AND COPPER-BASE ALLOYS

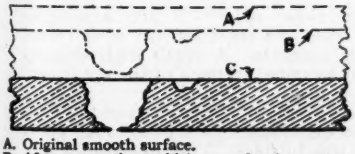
Prepared by Bridgeport Brass Company — "Bridgeport" — *Headquarters for BRASS, BRONZE, and COPPER*

What Gauge Condenser Tubing Should Be Used?

When considering the proper wall thickness of heat exchanger or condenser tubing many factors must enter into the decision. Since each of these has some bearing on the others, all must be carefully weighed before any selection is made. Five of the most important will be discussed.

(1) Corrosion

Severity and rate of corrosion taking place in a given installation will, of course, have important bearing on any decision regarding the wall thickness of tubing. For example, let us take a surface condenser with tube walls of .032" (21 gauge) and a good grade of steam on the outside of the tubes. Assuming that the circulating water attacks the metal at a rate of .002 ipy (inches per year) with a maximum pit depth of .016", the tubing should have a life of approximately 8 years (.002x8+ .016=tube thickness of .032). Under the same conditions, tubing with a wall thickness of .049" (18 gauge) the life expectancy should be approximately 18 years. In other words, the additional .017 inch of metal more than doubles the life of the tubing in this particular case. This partially explains why .049" tubing is more universally used than are the lighter gauges.



A. Original smooth surface.
B. After some time, thickness of tube wall is reduced by corrosion, and pit has formed.
C. After still longer exposure, tube wall further reduced by more corrosion. Pit depth remains approximately the same, but now perforates the wall forming a pin hole.

It must be noted that the average rate of corrosion and maximum depth of pitting varies with service conditions and character of the tube alloy. Better corrosion resistance of an alloy may more than make up for additional wall thickness, and merits the most careful study.

(2) Mechanical Characteristics

For ease of installation, straight lengths of condenser and heat exchanger tubing must have the proper amount of rigidity, which in turn depends upon the wall thickness and temper, (hardness). Tubing which readily bends, sags, or dents will not permit the smooth, uninterrupted flow of liquid which is necessary for maximum efficiency. Flaring operations or rolling the tubes into the sheet are factors which also must be considered. If the walls are of too light a gauge or the metal has the wrong temper, it will be impossible to make a tight, dependable joint with the tube sheet. In bending operations, wall thickness and temper of tubing are also important. In the construction of heat exchangers, for example, tubing must frequently be bent into hairpin turns and spiral shapes. Even though the metal has good ductility, walls which are too thin may result in the tube wrinkling or flattening.

(3) Heat Transfer

In most installations, thickness of the tube wall is not particularly significant from the standpoint of overall heat transfer (usually called the U value), because films, scales, or deposits on both sides of the tubing greatly affect its heat transfer properties. Surface film generally retards heat transfer much more than does the metal itself. For example, clean Admiralty metal has a thermal conductivity of 760 B.T.U./hr./sq. ft./ °F./in. On the same basis, water has a value of only 4.2, and air a value of only 0.15. It is evident from these figures that a thin film of water or air on a tube surface acts as an insulator and, therefore, has a profound influence on the overall heat transfer characteristics of the tubing.

Proper gauge means longer tube life and increased efficiency.

(4) Working Pressure

This has a very definite bearing on the gauge selected because higher working pressures require greater wall thicknesses. This is not important in surface condensers which operate at comparatively low pressures. However, certain types of heat exchangers operating at hundreds of pounds pressure, require tubes designed for such conditions. Also, allowance for corrosion attack must of course be made in figuring proper gauge because the factor of safety diminishes as the tube is thinned and weakened by corrosion.

(5) Economics

In addition to the initial cost of tubing, factors such as capital investment, cost of maintenance and repairs, cost of interrupted service, all are a part of the picture.

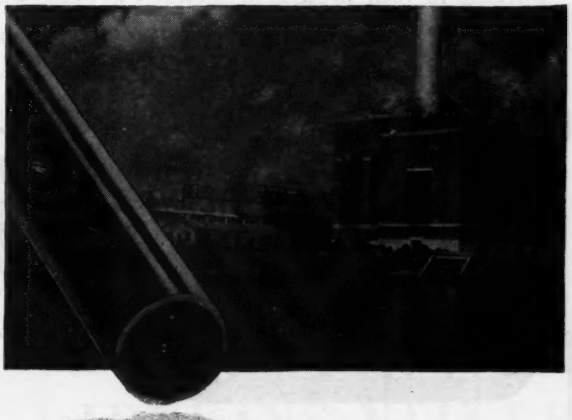
The factors discussed above should be taken into consideration by operators who contemplate buying condenser tubing.

When considering retubing, the operator who has had years of experience with his condenser or heat exchanger and who has kept careful performance records is in a position to use the above factors to obtain tubing which will give him greater efficiency and economy than he was able to obtain from his previous installation.

Your nearest Bridgeport Office will be glad to cooperate in making available the full resources of Bridgeport's laboratory to help you select the proper tubing.

Condenser Tube Manual

In the meantime, write for 112-page condenser tube manual; 39 photographs, 29 diagrams, 23 tables, corrosion research data, specifications for modern tubing alloys.



Note: Bridgeport products are supplied in accordance with existing priority regulations.

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HENSZEY CONTINUOUS BLOWDOWN

to help provide an abundance of LOW COST POWER and CLEAN STEAM!

The Henszey System keeps boiler water concentration within safe margins—insuring clean, efficient boilers and equipment by preventing foaming, priming, carryover and the formation of sludge and scale (with proper chemical treatment).

All this positive boiler water control is accomplished continuously, and automatically—without heat loss!

Check the advantages of the Henszey Blowdown System as applicable to your present or planned boilers. Send for folder "Complete Automatic Control of Boiler Concentration."

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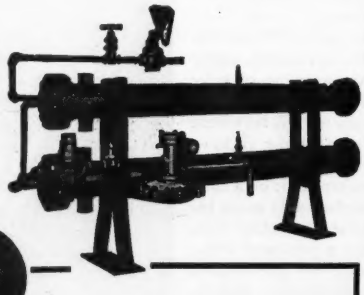

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CONTINUOUS BLOWDOWN

Flow Indicators • Distillation System • Heat Exchangers
Feed Water Meters • Boiler Feed Regulators • Proportioning Vavles

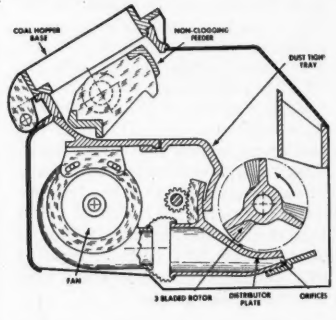
tested by experienced instrument mechanics are said to save installation time, to insure the use of suitable materials, to reduce total installed cost, and to present a neat, pleasing appearance. All piping and wiring necessary for operation is installed as a unit according to a co-ordinated and prearranged plan.

Small units such as valves, relays, switches, signal lights, and the more sturdy and light-weight instruments are mounted and connected ready for service. Heavy instruments or instruments having delicate mechanisms are shipped separately; but cutout spaces, drilling and all necessary connections are provided so that their installation in the field is a foolproof, quick and easy operation.

Spreader Type Stoker

THE JOHNSON & JENNINGS CO., 875 Addison Rd., Cleveland 14, Ohio, has recently introduced the J & J Spreader Type Stoker. One of its features is the sturdy, rugged, non-clogging and dust-tight coal feeder. It is adjustable for various operating conditions and is said to prevent any spillage of fines along the front of the stoker.

A three bladed rotor receives the coal from the feeder tray and discharges it into the furnace off the end of the distributor plate, the position



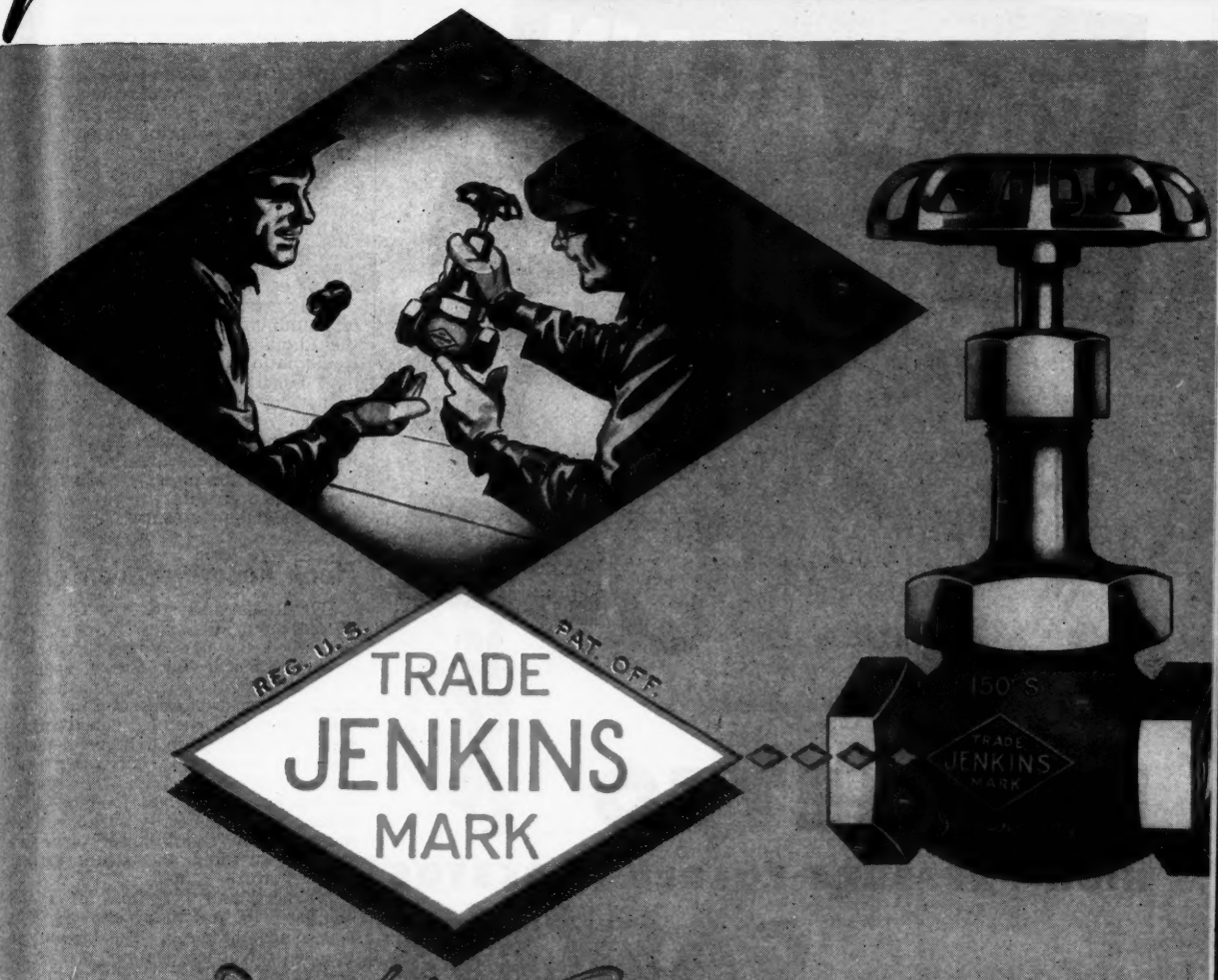
and slope of which are adjustable to meet the requirements of different size furnaces. A small high velocity fan mounted in back of the rotor, and discharging through orifices under the distributor plate, catches the fines and distributes these also to all parts of the furnace. This overcomes any tendency of the fines to drip down on to the furnace hearth, prevents any segregation of fines on the front grates, and lump on the rear grates, thus producing an even homogeneous fuel bed, and ideal burning conditions.

All exposed parts of the stoker are air-cooled. This is accomplished partly by the air entering the furnace through the orifices under the distributor plate, and partly by the secondary air from the windbox introduced through side tuyeres in the front arch to support combustion.

Improvements in Radiation Pyrometers

BROWN INSTRUMENT CO., Philadelphia, has introduced five major improvements in its compensated radiation pyrometers which make these

Your Guide to TRUSTWORTHY VALVES



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Look for the famous JENKINS DIAMOND-SIGNATURE TRADE MARK *and be sure of Extra Value in Valves*

For more than 80 years, the familiar Jenkins Diamond Trade Mark has been the symbol of supreme quality in valves.

It is the mark that distinguishes valves of extra value . . . value assured by the superior materials that go into them, by the resourceful men who make them, by the integrity that has become synonymous with the name Jenkins.

Valves worthy of the universal trust the Jenkins Diamond has earned are the only valves that will ever bear this mark. It is our pledge to you of the finest quality it is possible to provide . . . now, and as long as Jenkins Valves are made.

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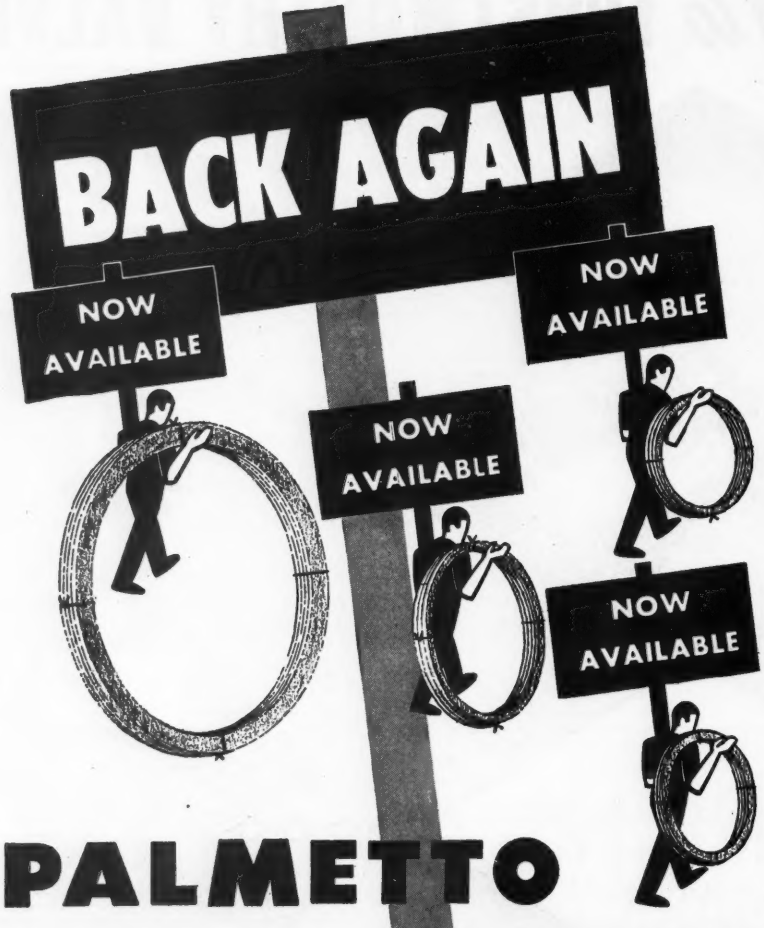
JENKINS VALVES

SINCE 1864

For every Industrial, Engineering, Marine and Commercial Service . . . In Bronze, Iron, Cast Steel and Corrosion-resisting Alloys . . 125 to 600 lbs. pressure

Sold Through Reliable Industrial Distributors Everywhere



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HIGH-PRESSURE FOLDED ASBESTOS

GASKETS

for Handholes and Manholes of Boilers and for Other Steam Services. Your inquiries and orders will receive prompt attention. Order TODAY.

PALMETTO Asbestos Metallic Sheet Packing *is also now available*

GREENE, TWEED & CO.

Manufacturers of the Famous PALMETTO Packings for Every Service

Bronx Blvd. at 238th St., New York 66, N.Y. Plants at New York, N.Y. and North Wales, Pa.

Radiamatics secure against air and gases up to one pound per square inch gage pressure at temperatures up to 250 F.

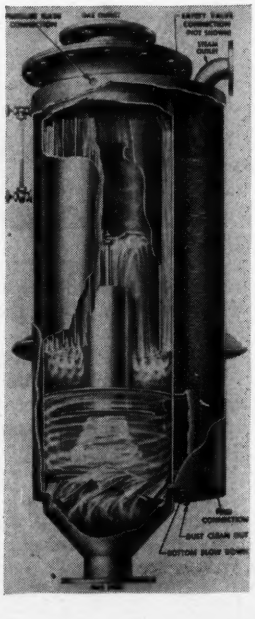
The five improvements are: 1, Use of an adhesive sealing compound between the lens and mounting ring; 2, Use of brass for lens retaining and mounting rings; 3, Controlled torque is applied when assembling the lens retaining and mounting rings; 4, Two spanner wrench holes in the lens mounting ring face have been replaced with a milled slot which avoids cutting through the ring face, and, 5, Use of a more positive sealing, with an improved adhesive, of the sighting glass located in the rear of the thermopile assembly.

Other improvements include use of aluminum instead of cast iron for the Radiamatic housing. The Brown Radiamatic consists essentially of a heat resisting lens, a compensator and a thermopile. Energy radiated from the hot object being measured falls on the lens and is focused on the thermopile which generates an emf proportional to the object's temperature. The measurements are independent of ambient temperatures.

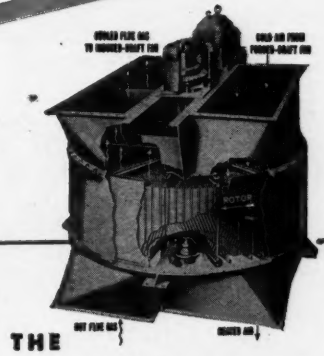
Heat Recovery Silencer

ENGINEERING SPECIALTIES CO., INC., 39 Cortlandt St., New York 7, has developed the new Vortex Heat Recovery Silencer for Diesel engines. It is designed for both marine and stationary installations and combines four functions in one construction: steam generation up to 30 psi depending upon the service, hot water heating, exhaust silencing and the removal of sparks and carbon from exhaust gases. Yet, it normally occupies little more space than spark arrester-silencers without the steam or hot water features.

Owners and operators of Diesel engines will find many uses for this waste heat silencer. The steam can be used for space heating, processing and other services. And the unit is equally useful when functioning as a



New Solutions to Heat Recovery Problems may begin with PREHEAT ENGINEERING



THE

LJUNGSTROM AIR PREHEATER

The continuous, regenerative, counterflow principle of the Ljungstrom Air Preheater provides a maximum heat transfer with minimum weight and size. The rotating, cylindrical heat-transfer surface "soaks up" heat in the hot gas chamber, then rotates into the chamber where it gives up this heat to the entering air.

If heat recovery is important to your process, it's possible that some standard or special application of preheat engineering may lead to new operating economies. Here are four specific reasons why you should call in the preheat engineer when plans for new plants, or modernization of old ones, are under consideration.

1. You can design furnaces to take advantage of the benefits of higher heat recovery.
2. Recent new preheater uses, including application to a reverberatory copper-smelter furnace and special applications in sewage treatment plants may indicate how you can increase the efficiency of your production processes.
3. You can take advantage of the added efficiency which generally results from designing a plant specifically for use with the Ljungstrom Air Preheater.
4. The air preheater engineers can help you solve problems arising from corrosion or deposit formation on the heat exchange surface.

So, while your plans for the future are still on the drafting tables, why not check with our engineers?

THE

AIR PREHEATER

CORPORATION

Executive Offices: 60 East 42nd Street, New York 17, N. Y. • Plant: Wellsville, N. Y.

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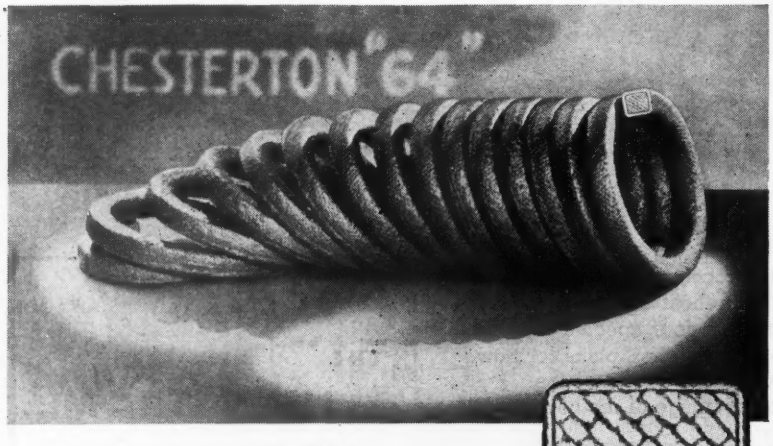
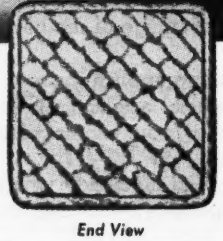
Pacemaker
ON HIGH PRESSURE STEAM ROD PACKING JOBS...

You'll find Chesterton "64" a favorite with engineers for packing rods working against high pressure steam, superheat and hot gases. Each ply of asbestos cloth is *diagonal* rather than parallel to the rod.

Thus, expansion and elasticity are provided mechanically; and this improved packing design reduces friction as much as 50%. Ask for Catalog 22 which describes complete Chesterton line; includes Packing-Selector Chart and other useful handbook data.

Write for FREE 72-Page Packing Handbook





End View

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Factories: Melrose, Mass.; Chicago, Ill.

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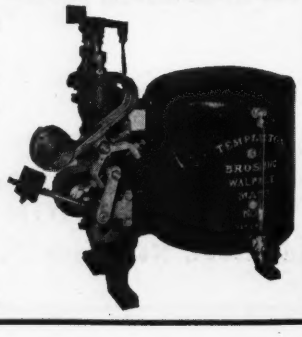
TEMPLETON RETURN STEAM TRAPS
for Pumping, Boiler Feeding, Draining, Heating and Vacuum Lines

- Pumps Water at any temperature or pressure.
- Open float cannot burst or waterlog.
- Valves and Seat Bronze or Stainless Steel.
- Sizes 1 in. to 4 in. inlet and outlet.
- Capacity 2500 lbs. to 60,000 lbs. water discharge per hr.



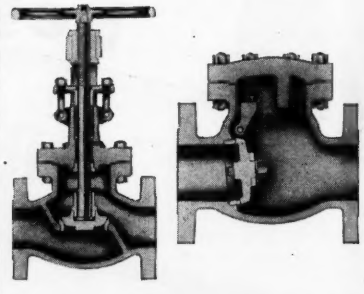
Ask for catalogue and prices

TEMPLETON BROS., INC.
699 Main St. Walpole, Mass.

hot water boiler. Furthermore, in many instances it will serve as an auxiliary to separately-fired steam generators and hot water boilers or as an adjunct to carry peak loads. In other situations, where Diesel engine users have only intermittent need for steam or hot water, this silencer can be operated dry or partially filled without risk or damage.

Steel Valves

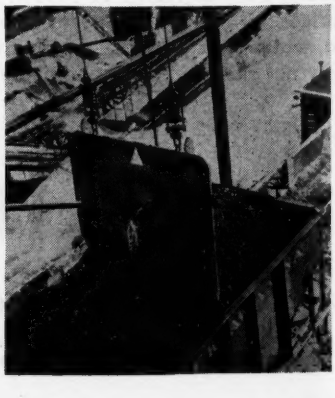
THE OHIO INJECTOR CO., Wadsworth, Ohio, has announced the development of two new lines of cast steel valves. A complete line of OIC cast steel globe and angle valves is now available in the 150 and 300 lb pressure classes. An essential feature is the fact that they are offered with either spherical or plug type discs and seats, in a number of trims, adapting them to fluid control in either full-flow or throttling service.



The other development is a new line of OIC cast steel swing check valves in the 150 and 300 lb pressure classes. They are the full-way type in which the disc completely clears the waterway in the wide open position. The complete disc assembly is suspended from brackets inside the body and is removable as a unit through the cap opening.

Coal Slicer Hoist

SILENT HOIST & CRANE CO., Brooklyn 20, N. Y., has designed and placed on the market a two-drum electro-hydraulic, friction-clutch worm-geared hoist for operating a coal slicer. This coal slicer hoist raises and lowers a slicer bar which chops up the coal so that it will freely flow through the underside trapdoor into the hopper of the conveyor. The coal slicer bar, in



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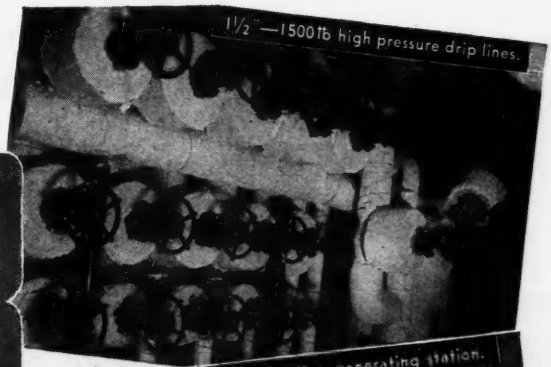
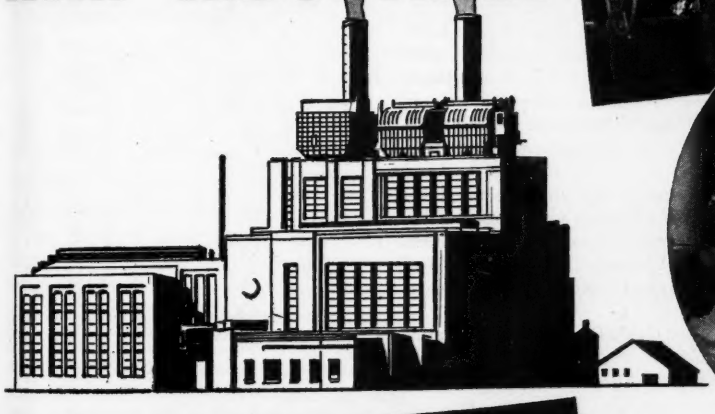
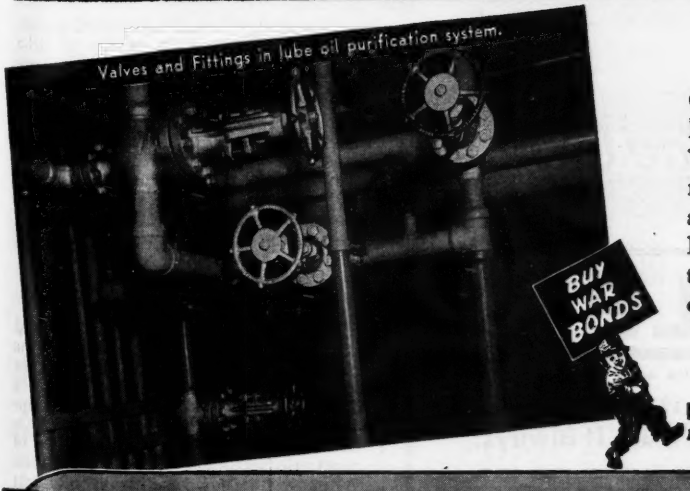

1½"—1500lb high pressure drip lines.

1"—400lb lines in a leading generating station.



Desuperheater Manifold with 1¼"—600lb valves.



● **SAFE and SURE control of vapors and liquids in steam generating plants serving our War Industries is dependent on piping materials having an inherent "plus" of strength and toughness. *Drop Forged Steel* Valves, Fittings, and Flanges made by Vogt continue to play a vital part in the smooth, efficient operations of America's leading power plants.**

Catalog F-8 is the *drop forged steel* Valve and Fittings Blue Book.

HENRY VOGT MACHINE CO., Louisville 10, Kentucky
Branch offices: **New York, Philadelphia, Cleveland, Chicago, Dallas.**

Vogt DROP FORGED STEEL **VALVES, FITTINGS & FLANGES**

The PYREX Broad Red Line Gauge Glass is ideal for those hard-to-see places. It is made of corrosion resistant, borosilicate glass with this plus feature—maximum visibility even at a distance.

The refraction of the light through the water causes a well defined difference in width of the red line above and below the fluid level so that the height of the fluid column is easily and definitely seen.

PYREX Broad Red Line Gauge Glasses give you everything you need in a Gauge Glass: machine drawn accuracy that makes installation easy, resistance to thermal and mechanical shock, crystal clearness that is virtually unaffected by the action of steam and water—plus the safety and convenience of the easy-to-read Broad Red Line.

There is a PYREX or CORNING Gauge Glass for every operating condition. They are stocked by all leading Mill Supply houses.

Industrial Sales Department, PF4, Corning Glass Works, Corning, New York.

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Pyrex Gauge Glasses

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THE PACKING THAT "PACKS ALL"

. . . use it once and

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Here's the universal packing that can be used for any fluid or on any apparatus—economically, efficiently—tightly—simply.

Try ALLPAX and you, too, will be enthusiastic over its easy application and long wear. You don't have to remove old packing to repack with ALLPAX. Square cross section makes ALLPAX easy-filling in any stuffing box.

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THE ALLPAX CO., INC.
Mamaroneck, N. Y.

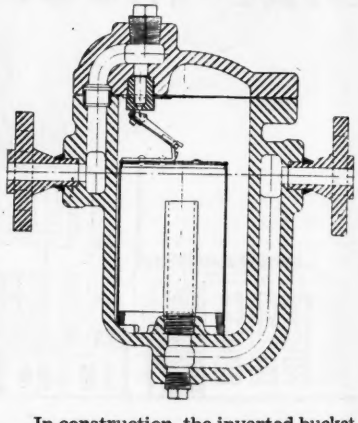
Distributors Everywhere

combination with the hoist, also helps to move the coal from the various pockets of the hopper car to the trap-door. It permits fast and clean unloading of the coal, reducing considerably the amount of manual labor formerly required since it eliminates the need for men to operate crowbars, sledges, elaborate thawing of ovens or torches.

The coal slicer hoist is mounted on the existing overhead bridge crane that may be in service, and is operated from the crane cab. One user, in recent sub-zero weather, was able to unload 38 cars of frozen coal in a single day.

Cast Steel Steam Trap

ARMSTRONG MACHINE WORKS, Three Rivers, Mich., has designed for pressures up to 600 psi or where all steel fittings are desired, a new cast steel inverted bucket steam trap with side inlet, side outlet pipe connections. It is available with ½, ¾, or 1-in. screwed or flanged connections. Flanges are welded into the trap body. Height is 11¼-in.; dimensions between flanges range from 11⅝ to 12⅛-in., depending upon pipe sizes.



In construction, the inverted bucket and valve lever are made of 18-8 stainless steel; the valve and seat are chrome steel hardened, ground, and lapped. One of the features of the trap is that the cap and interior mechanism can be removed for inspection or repair without breaking either the outlet or inlet connections. The cap and working parts are removed as a unit by unbolting the cap, leaving the body intact on the line.

Magnetic Type Strainer

WINSLOW ENGINEERING CO. of Oakland, Calif., has placed on the market a new magnetic-type strainer for use in the lubricating oil lines of steam turbines, or other power equipment to remove filings and metal particles through the combination of magnetic action and screening, the Winslow strainer combines in one unit the by-pass valves, pressure regulator, main control valve, and the two strainer elements in which powerful magnets are located.

A quick-acting hand-operated three-way control valve permits the change of flow from one strainer element to the other, or through both elements.

HEAT PROVER..QUICKLY REVEALS INCOMPLETE COMBUSTION

FREE Demonstration Test Will Help Solve Your Combustion Problems . . . Conserve Fuel . . . Increase Quantity and Quality of Your Product.

Today, like many engineers in both small and large industrial plants, you very likely want to know—*by accurate measurement*—the answers to these four vital problems:

1. **Just how efficiently do my boilers burn fuel?**
2. **How efficiently do wartime operators control them?**
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4. **And what, actually, is the status of my combustion control equipment?**

To all these questions—and more—Cities Service has the almost perfect answer in the Cities Service INDUSTRIAL HEAT PROVER. This unique instrument quickly analyzes combustion . . . accurately determines degree of fuel waste due to air deficiency or dilution. Thoroughly tested on practically every type of combustion equipment in this country and with every kind of fuel, the Industrial Heat Prover already has been adopted by users of steam power plants, open hearth furnaces, cement kilns, heat-treating apparatus, crucible furnaces and internal combustion engines. And for a very good reason.

Accurate combustion analyses made as a result of the Cities Service Industrial Heat Prover tests have effected considerable savings in fuel costs...reduced repairs and replacements on furnace linings, crucibles and refractories due to flame corrosion... and have led to increased production of better and more uniform products.

Why not get a Cities Service Industrial Heat Prover Test in your own plant? You may have it *without cost or obligation*—if you will simply mail the coupon at right. A Cities Service Engineer will then make an Industrial Heat Prover Test in your plant—at your convenience. Mail the coupon—today.

THE CITIES SERVICE INDUSTRIAL HEAT PROVER—a new, accurate combustion analysis instrument developed by the Cities Service Research Division enables those engaged in the oxygen control of furnace atmospheres to achieve greater combustion efficiency at less cost.

(This offer is available only in Cities Service marketing areas EAST of the Rockies.)

CITIES SERVICE OILS — ONCE-ALWAYS

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Gentlemen: Please arrange a Cities Service Industrial Heat Prover Test for my plant. I understand there is no charge or obligation for this service.

Name.....

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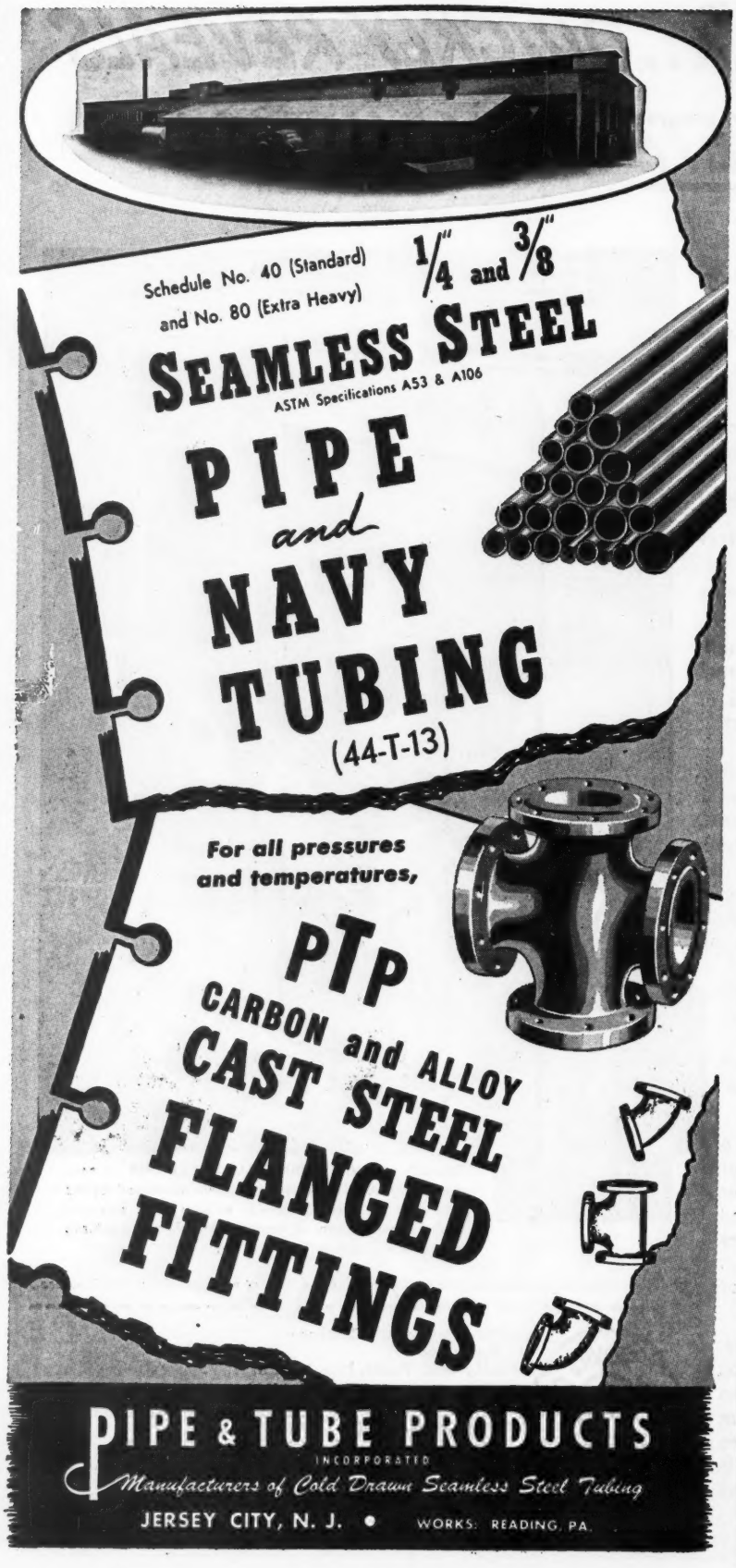
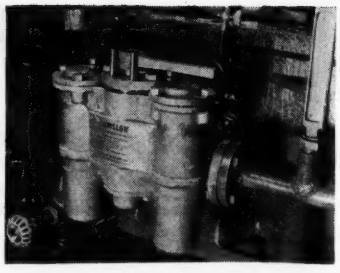




The flow control valve has been greatly simplified and requires no jacks to lock it in place. Adjacent to this three-way valve is the pressure regulating valve, for adjustment of out-going oil pressure.

The Model 200-MS-1 Winslow Duplex strainer is of either cast bronze or iron for the one-piece body which incorporates the manifold, the strainers, inlet and outlet connections. The two cylindrical baskets are constructed around a main body of perforated steel, within which are fine wire mesh linings. The magnets are suspended within the baskets.

In the body is located a spring loaded by-pass valve that may be adjusted from the outside. The Model 200-MS-1 is designed to handle 15 gpm. A larger, model to handle 40 gpm is available.

Obituaries

John Robert Hagemann

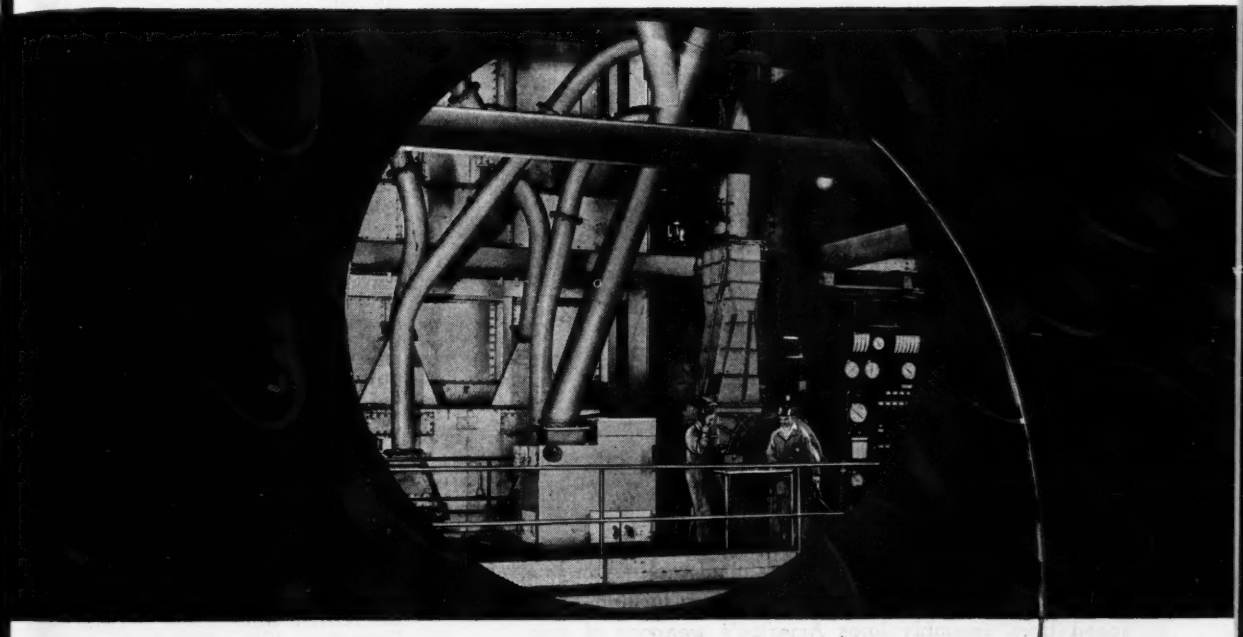
JOHN ROBERT HAGEMANN, manager of engineering in the steam turbine department of the Allis-Chalmers Manufacturing Co., died on February 15 at the age of 44. Mr. Hagemann was born in Switzerland, graduated from the Swiss Federal Polytechnic Institute, Zurich, Switzerland, where he was a student of Dr. A. Stodola. He came to this country in 1927 as an engineer for the Brown-Boveri Co. of Switzerland. He joined Allis-Chalmers in 1929 being made assistant engineer in 1934. In 1942 he became engineer in charge of power steam turbine design and in 1944 he was appointed manager of engineering in the steam turbine department.

C. F. Burgess

DR. CHARLES FREDERICK BURGESS, the founder and director of the Burgess Manning Co., Chicago, Ill., died on Tuesday, February 9, 1945. Dr. Burgess was born in Oshkosh, Wis., on January 5, 1873 and was from 1895 to 1913, successively instructor, assistant professor and professor of Applied Electro-Chemistry at the University of Wisconsin. He also served on the Wisconsin Railroad Commission and became President of the C. F. Burgess Laboratories, Burgess Battery Co., Burgess Dry Cells, Ltd., and Chairman of the Burgess-Parr Co. He was the inventor of the process for electrolytic purification of iron, also, of vari-

DOWELL

CHEMICAL SCALE REMOVAL SERVICE



DISSOLVES, DISINTEGRATES AND REMOVES

THE THIEVES OF POWER

Safely, thoroughly—with speed—the heat exchange surfaces of American industrial plants are freed of their power-stealing water- and steam-deposited scale, sludge and oxides by Dowell chemical methods.

A minimum of down-time is required for this important work—usually only a few hours—and there is no extensive dismantling of equipment.

Inhibited solvents, prepared for the particular job, dissolve and disintegrate the deposits without damage to the equipment.

Dowell Chemical Cleaning is another important cooperative development—the result of Dowell chemical and engineering techniques together with the research and technical facilities of its parent organization, The Dow Chemical Company.

Fully mobile equipment manned by trained engineers is on call from many strategic points in the United States. Write, wire or phone the most convenient Dowell office.

DOWELL INCORPORATED

Tulsa 3, Oklahoma

Subsidiary of The Dow Chemical Company

New York • Philadelphia • Cleveland • Chicago • St. Louis • Houston
Kansas City • Wichita • Mt. Pleasant, Michigan • Salem, Illinois
Long Beach, California • Casper, Wyoming

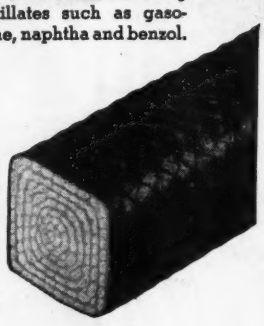
Service from Long Beach and Casper provided by a Dowell associated company, International Cementers, Inc.

BELMONT PACKINGS

FOR GASOLINE SERVICE

Belmont 6100

For rod and valve stems handling volatile distillates such as gasoline, kerosene, naphtha and benzol.



FOR HOT OIL SERVICE

Belmont 189

For rods and plungers handling hot or cold oil—all temperatures.

For OIL

PACKINGS are important in every plant production program. They keep the machines of industry turning—help speed from assembly lines America's weapons of war.

AND . . . now, when equipment must stand the strain of 24-hour-a-day operations—it's vitally important that just the right packings be selected for every job.

Above are two of the many Belmont Packings especially made for petroleum services. Both 6100 and 189 are made from asbestos yarn, braided and treated with suitable lubricants for maximum operating efficiency.

Any Belmont distributor (they are located in every large industrial center) will be glad to offer suggestions on your requirements. Or write on your company letterhead for a copy of the Belmont Packings Catalog displaying the complete Belmont Line.

THERE'S A BELMONT PACKING FOR EVERY SERVICE

Steam, Water, Oil, Gas, Air, Acids, Alkalies, Ammonia

Rings, Spirals, Coils, Reels, Spools, Sheets, Gaskets.

THE BELMONT PACKING & RUBBER COMPANY

BUTLER AND SEPVIVA STREETS • PHILADELPHIA 37, PA.

ous iron alloys and improvements in dry cells. He was a recipient of the Octave Chanute Medal awarded by the Western Society of Engineers in 1911 and had received many awards for his achievements in science and engineering.

Philip Gadsden

PHILIP H. GADSDEN, who retired January 1, 1942 as vice-president of The United Gas Improvement Co. of Philadelphia, died in that city on February 27 at the age of 77 years. In 1900 Mr. Gadsden became vice-president of the Consolidated Railway and Lighting Co. of Charleston, S. C., which was the beginning of his long career as a public utility executive. He served as vice-president of the Charleston Light and Water Co. from 1907 to 1917 and as a member of the Federal Electric Railways Commission in 1919. During World War I he was chairman of the war board of the American Electric Railway Association and chairman of the National Committee on Public Utility Conditions. Also chief of the Philadelphia District Ordnance Office of the War Department. He was president of the American Electric Railway Association in 1921, president of the Southern Gas Association in 1922 and president of the Eastern States Gas Conference in 1923. He became vice-president of the United Gas Improvement Company in 1919.

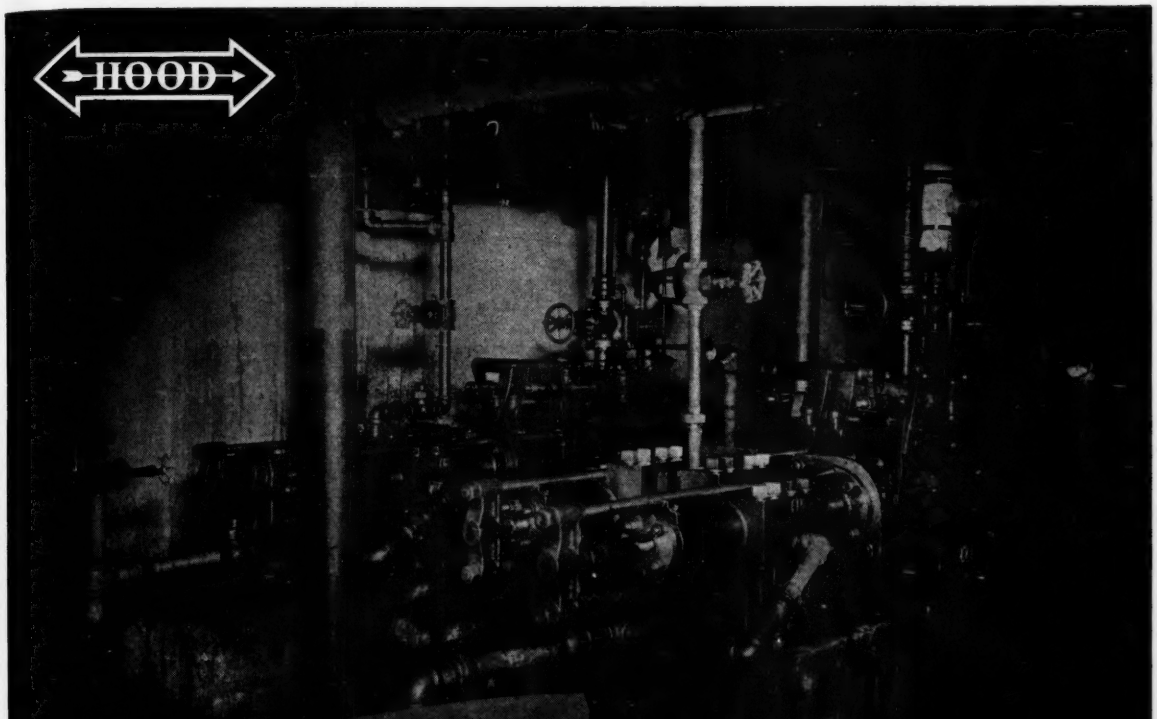
James Lincoln Ashley

JAMES LINCOLN ASHLEY, director of the entire International Nickel Company of Canada, Limited, who died March 6 in New York, was formerly secretary and treasurer of The International Nickel Co. of Canada, Ltd., and vice president and treasurer of The International Nickel Co., Inc., a United States subsidiary. He retired from active service in December, 1939. Mr. Ashley was born in New York on October 14, 1869, and after receiving his education for college he joined the staff of Joseph Wild & Co., of New York, where he remained until 1902. He became associated with Mining and Metallurgy when the International Nickel Co. was organized in 1902. In the corporate reorganization in 1928 he was elected to the position of secretary and treasurer in the parent company and vice president and treasurer of its United States subsidiary. Mr. Ashley had served as a member of both the board and executive committee of the American Bank Note Co. and a trustee of the Union Dime Savings Bank. He was formerly director of the Liberty Bank, the New York Trust Co., and the Equitable Trust Co., of New York City.

MANUFACTURERS' *News*

Homestead Valve Manufacturing Co. has recently started production in its new cleaning-compound manufacturing plant at Edgeworth, Pa. The new plant will supply industry and

HOOD



WARREN PUMPS

. . . ON SERVICES OF THE HEAVIEST CHARACTER AND MOST EXACTING TYPE

For example, take the pair of Warren Duplex Hydraulic Pumps, 12 x 2½ x 12 shown in the accompanying photograph. One was installed in 1916 and the other in 1924 and are used on accumulators up to 2500 lbs. pressure per square inch. These pressures operate hydraulic presses for the final squeeze on various well known rubber products manufactured by Hood Rubber Company.

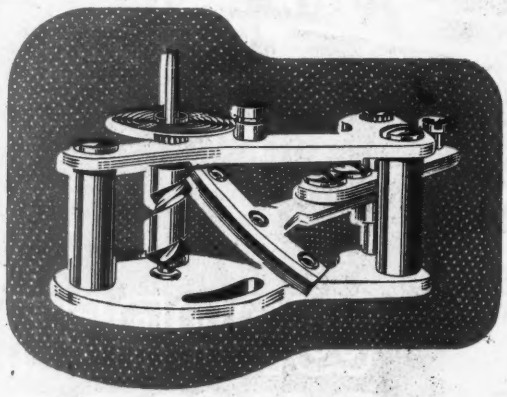
Year after year these Warren hydraulic installations have operated at a high degree of efficiency and with very low maintenance cost. This goes also for other Warren hydraulic installations at Hood, the first of which dates back to 1911.

FOR LONGER LIFE AND GREATER DEPENDABILITY

WARREN STEAM PUMP CO., INC.

WARREN, MASSACHUSETTS

HERE'S A LITTLE MOVEMENT WITH A MEANING ALL ITS OWN



And this little movement has special significance to you as a pressure gauge user. It means longer gauge life and greater accuracy. As you can see, the Helicoid Movement has no teeth to wear or foul. The polished Bakelite cam facing simply rolls smoothly in the polished groove of the hard roller. Friction and inertia are reduced to minimum.

Only Certified Gauges have the patented Helicoid Movement.

Now, after several years use in the Navy, Certified Gauges are available to industry. Many of the largest companies in the country are already using them.

All Certified Gauges are guaranteed accurate to within ½ of 1%. They stay accurate longer. Send for catalog today.

Certified GAUGE AND INSTRUMENT CORP.

34-18 Northern Boulevard — Long Island City 1, New York

all branches of the armed forces with compounds for Hypressure Jennys and other steam spray cleaning machines to restore machinery of all kinds to a clean condition.

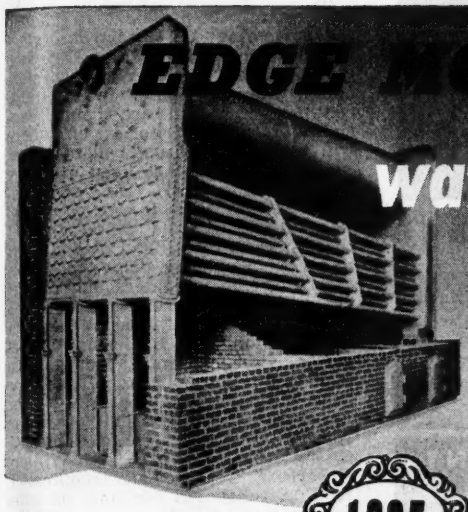
The Eagle-Picher Lead Co. has recently acquired the production and distribution facilities of the Southern Lead Co. of Dallas, Texas. The products of the newly acquired Dallas plant will be sold under Eagle-Picher name, but the personnel of Southern Lead Co. will be retained under terms of the agreement. J. M. Bowlby, is the president of the Eagle-Picher Lead Co., Cincinnati, Ohio; W. F. Murdock, general manager of the Metallic Products Division; J. V. Murph, general manager of the Dallas plant; D. Bentley Murph will be in charge of production at that plant and D. H. Murph, founder, will remain in a consulting capacity. Operations will be conducted under the newly created firm name, Eagle-Picher Co. of Texas.

The B. F. Goodrich Co. has taken options on land near Avon Lake, Ohio as a probable site for the construction of an experimental war chemicals plant. The company's chemical division now operates plants in Ohio, New York, Kentucky and Texas. Announcement also is made that a new research laboratory will be constructed in Brecksville, Ohio, for which complete principal plans, and designs and construction work will soon be started.

Builders-Providence, Inc., Proportioneers, Inc., and Omega Machine Company, recently joined to celebrate the 125th birthday of the parent company, Builders Iron Foundry, with a service award dinner for 270 employees who have been with the company for 5 years or more. Since its founding in 1820, this company has consistently grown both in size and in the scope of its operations. In 1887 Clemens Herschel developed the Venturi Tube for which Frederick N. Connet, Chief Engineer of Builders Iron Foundry, perfected the necessary instruments. The resulting Venturi Meter was an outstanding scientific achievement and in the years that followed, the company expanded its activities and designed, manufactured and distributed a wide variety of flow measuring and flow controlling instruments that found applications in industry, power plants and water and sewage works throughout the world. A little more than a decade ago the parent company participated in the organization of Proportioneers, Inc., for whom it manufactures constant rate and flow proportional pumps and in the past year Builders acquired the Omega Machine Co. of Kansas City, manufacturers of volumetric and gravimetric feeders for dry and fluid materials.

The Automatic Control Division of Climax Industries, of which Climax Engineering Co. is a division, has been formed by the affiliation of this company, the Hanlon-Waters Co. of Tulsa, and the McAlear Manufacturing Co. of Chicago. General management, sales and engineering are being centered under single heads in charge of these executive functions for McAlear and Hanlon-Waters plants. Edward F. Deacon, Climax president, has announced the following new appointments: L. J. Griffey, vice-presi-

EDGE MOOR water tube boilers



VINTAGE 1895 • THE FIRST EDGE MOOR WATER TUBE BOILER

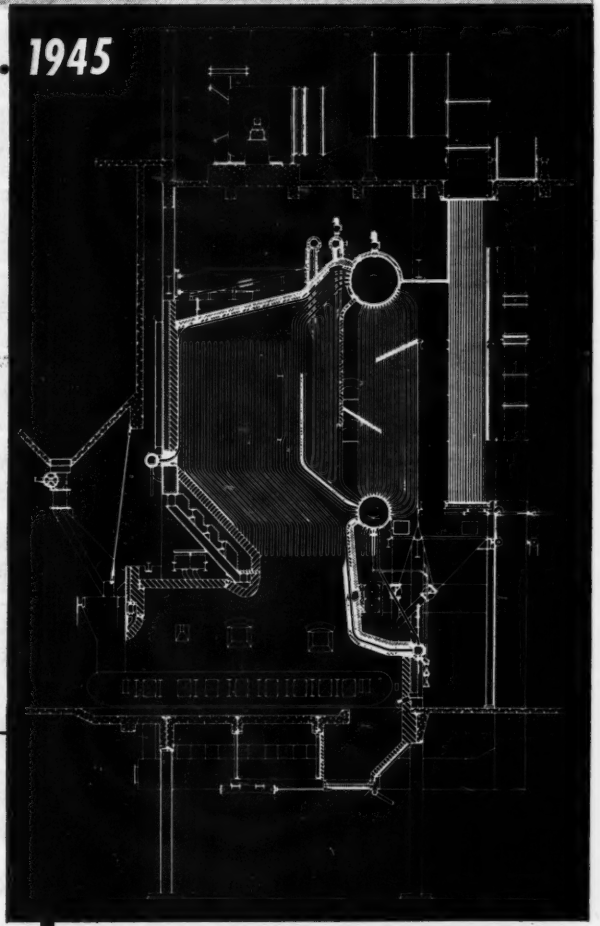
An Edge Moor Catalog of 1902 states: "This boiler is still in active service, and demonstrates that our boilers were designed on sound principles, and only improvements in details were necessary to make them what they are today."

1895 1945

Edge Moor was established in 1868 and has been building steam generating units for nearly three-quarters of a century. Fifty years ago, in 1895, we began the manufacture of water tube boilers, and followed several years later with the first superheating steam boilers.

Edge Moor engineers have continued to contribute to the store of knowledge and experience gained in the building of steam generating equipment. Today, upwards of 5000 installations attest to the many advances in design, efficiency and standards of quality originated by Edge Moor.

Edge Moor boilers are designed for any required capacity and up to 900 lbs drum pressure. Complete steam generating units, auxiliary equipment and installation service are available—from Edge Moor.



Edge Moor 2-drum bent tube boiler with pendant convection superheater, vertical tubular air preheater, water cooled furnace, traveling grate stoker. Capacity, 75,000 lbs steam per hour; Drum Pressure, 450 psi; Degrees of Superheat, 300; Final Steam Temperature, 750° F.

STEAM GENERATING EQUIPMENT

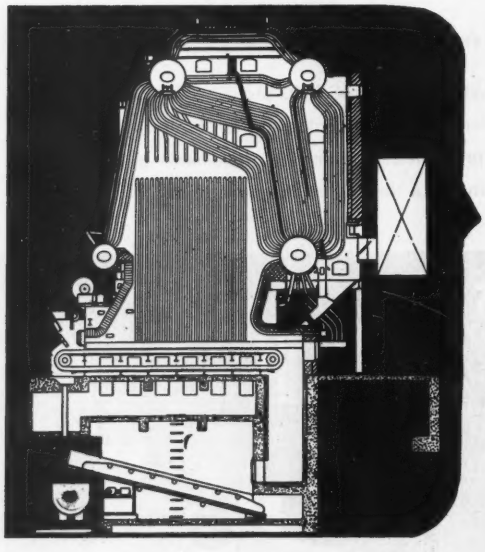
EDGE MOOR IRON WORKS, INC

BRANCH OFFICES: NEW YORK 20, N. Y.: 30 ROCKEFELLER PLAZA
CHICAGO 2, ILL.: ONE NORTH LA SALLE STREET

MAIN OFFICE AND WORKS: EDGE MOOR, DELAWARE

UNION

FILE THESE UNION ADS FOR REFERENCE



RADIANT TYPE

RADIANT TYPE

THIS is a patented 4-drum boiler design that doubles the usual radiant exposure found in 4-drum boilers. This Union front wall radiant element, together with the main tube bank, form an "A" shaped roof over the fire. This added radiant exposure, by absorbing fully ten times more B.T.U.'s per sq. ft. than the blind or convection heating surface, provides faster steaming, greater capacity, lower furnace temperatures and maintenance, and lower setting costs. These advantages and many others are completely described in Bulletin RB. Write for copy.

UNION IRON WORKS ★ ERIE, PA ★

BOILERS

PRESSURE VESSELS • PLATE FABRICATION

dent and general manager; M. C. Waterman, vice-president in charge of engineering; C. W. Snyder, vice-president in charge of sales. The two plants and all Hanlon-Waters branch offices and warehouses in the mid-continent oil field are being continued. Other territories elsewhere will be handled through distributors.

Announcement has been made by Walter Kidde & Co., Inc., of Belleville, N. J., that it has acquired through purchase the capital stock of the Youngstown Miller Co., Inc., formerly of Sandusky, Ohio, manufacturers of plastic coaters and oil reclaimers. It is reported that orders on hand will continue to be filled under the direction of F. L. Gerin, who becomes vice-president and general manager. Other officers of the new subsidiary of Walter Kidde & Co., Inc., will be John F. Kidde, president, Harold A. Cartier, vice-president, G. Crosby Hiss, secretary and William Deyerberg, treasurer and comptroller. R. E. Strobel will continue as sales manager for the Youngstown Miller products. The main office of the Youngstown Miller Co. will be located at 675 Main Street, Belleville, N. J.

MANUFACTURERS' *Personals*

Worthington Pump and Machinery Corp. has recently appointed George Steven to the post of executive engineer of its Buffalo Works. Harold W. Whiting will succeed him as chief engineer of the Buffalo Works Compressor Division.

Walter E. Moore was recently appointed district sales manager for the New York District of the American Cable Division of American Chain & Cable Co., Inc. Mr. Moore, who has been with the company for 18 years, will continue to make his headquarters at 230 Park Avenue, New York, N. Y.

Westinghouse Electric & Manufacturing Co. has announced the following changes in personnel and representation: O. A. Bruneau was appointed branch manager at Duluth of the Westinghouse Electric Supply Co. for the Northern District, to succeed F. A. Johnson who has retired. Alfred L. Goeke was appointed as service manager of the Tulsa, Oklahoma, branch of the Westinghouse Electric Supply Co. L. G. Hardy, formerly branch manager at Jacksonville and Tampa, Florida, has been appointed Southeastern District Appliance manager with headquarters at Atlanta, Ga. C. W. Spengler has been appointed acting manager of the Jacksonville branch. E. L. Houston is now acting manager of the Tampa branch. S. R. Clark has been appointed branch manager at Charlotte and Columbia, S. C. O. C. Rhodes is now acting manager of the Columbia, S. C., branch. R. E. Hallman is now acting manager of the Greenville, S. C., branch. John F. Myers has been appointed manager of the Middle Atlantic District of the Westinghouse Electric Supply Co. and will succeed H. M. Gansman, who retires after 41 years of service with Westinghouse.

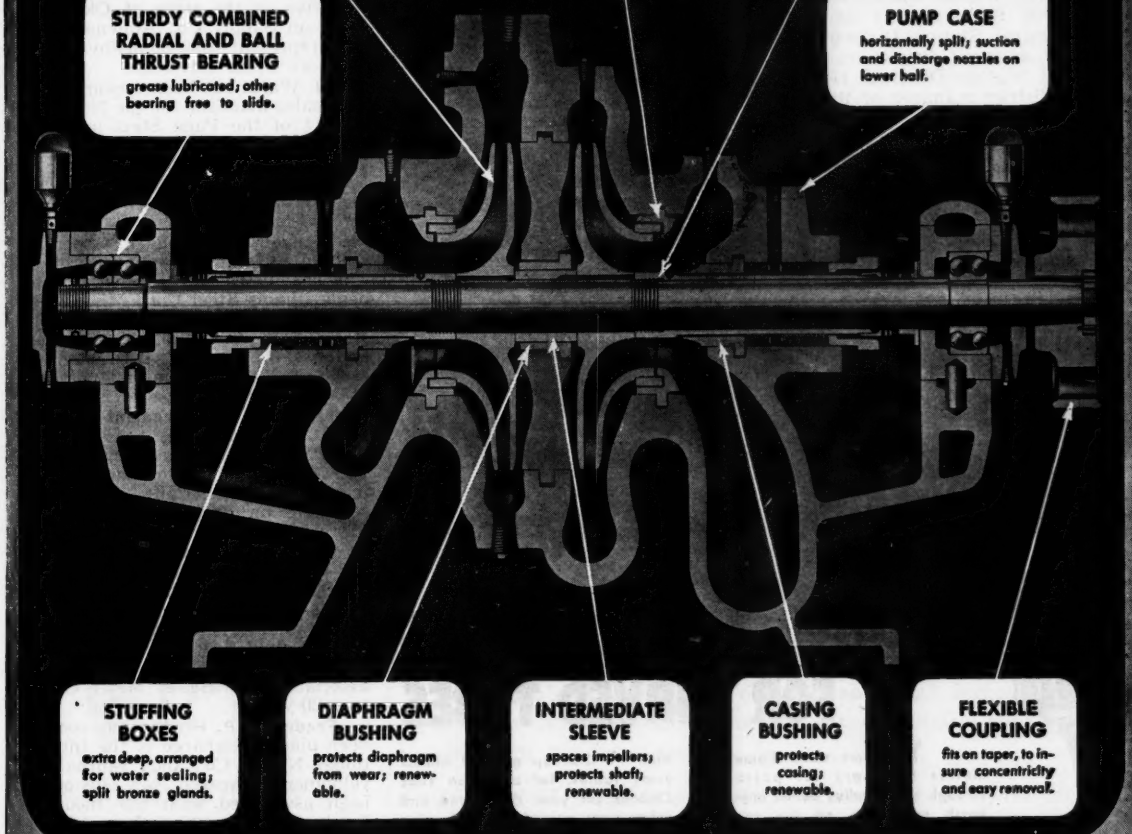
BRONZE SINGLE-SUCTION IMPELLERS
opposed to balance end thrust; accurately finished; hubs do not extend under diaphragm and so not subjected to wear.

BRONZE WEARING RINGS
protect both impeller and casing; permit larger clearance with less leakage, as compared with plain rings, hence last longer.

BRONZE SHAFT PROTECTING SLEEVES
screwed against impeller hubs; outer ends packed leak-tight, but free to expand.

STURDY COMBINED RADIAL AND BALL THRUST BEARING
grease lubricated; other bearing free to slide.

PUMP CASE
horizontally split; suction and discharge nozzles on lower half.



STUFFING BOXES
extra deep, arranged for water sealing; split bronze glands.

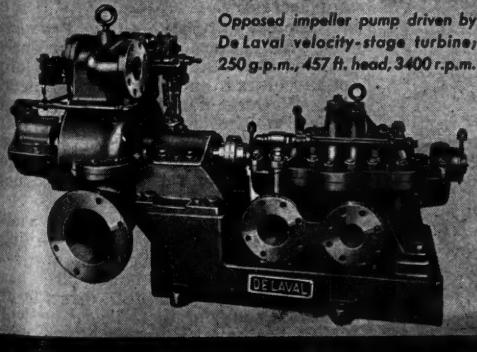
DIAPHRAGM BUSHING
protects diaphragm from wear; renewable.

INTERMEDIATE SLEEVE
spaces impellers; protects shaft; renewable.

CASING BUSHING
protects casing; renewable.

FLEXIBLE COUPLING
fits on taper, to insure concentricity and easy removal.

DE LAVAL *OPPOSED* IMPELLER PUMP



Opposed impeller pump driven by De Laval velocity-stage turbine; 250 g.p.m., 457 ft. head, 3400 r.p.m.

In this pump the two single-suction impellers have their suction inlets facing outwardly, thus balancing the pump hydraulically and requiring only two pairs of wearing rings. High efficiency is thus combined with simple construction. Pumps built in capacities up to 1500 g.p.m. and for heads up to 800 ft. Ask for Catalog P-3226.

DE LAVAL STEAM TURBINE CO. . . TRENTON, N. J.

John Howard Collier, president of the Crane Co., Chicago, has been elected director of the Allis-Chalmers Manufacturing Co., to fill the vacancy left by the resignation of Lester Armour who has been in the service of the Navy since the outbreak of the war.

General Electric Co. has announced the following changes in the New York district: G. H. Reid, assistant district manager; W. E. Brown, formerly manager of Central Station Division, will handle special assignments; H. M. Sliter, district manager of the Central Station Division; R. M. Darrin, assistant district manager of Central Station Division; Horace Zimmer, district manager of the Industrial Division, also, district manager, Transportation Division; H. M. Bardin will be sales manager of the federal and marine section; R. B. Ransom, manager of the New Haven office; and J. J. Pascher, manager of the Hartford office.

Foote Bros. Gear and Machine Corp., Chicago, Illinois, announces the election of the following additional officers: L. F. Campbell, vice-president in charge of manufacturing, Precision Gear Division; R. B. Moir, assistant vice-president in charge of sales engineering, Industrial Gear Division; E. A. Johnson, assistant vice-president in charge of manufacturing, Industrial Gear Division; I. C. McVicar, assistant secretary; L. J. Malina, assistant treasurer.

The long and short of
TUBE CLEANERS
FOR CURVED TUBES
The short, small diameter motors necessary for passage through short radius bends impose harsh restrictions on the power such motors will develop. This lack of power often slows up tube cleaning. It may even cause serious time charges through excessive down-time of equipment cleaned.
Wilson cleaners for curved tubes will help you overcome these and other troubles. There is a Wilson Tube Cleaner for every curved tube from 1" O.D. up and for almost every radius. Let a Wilson Tube Cleaner cut your down-time and solve your curved tube cleaning problems.
Thomas C. Wilson, Inc. maintains a large engineering staff for consultation on difficult or unusual tube cleaning problems. Write today for a copy of the new Wilson Tube Cleaner Check List and a 40-page bulletin describing the complete line of Wilson Tube Cleaners. No obligation.
Modern tube-cleaners for the problems of today.
wilson
THOMAS C. WILSON, Inc.
21-11 44th AVENUE, LONG ISLAND CITY 1, NEW YORK

The Briggs Clarifier Co., Washington, D. C., has recently announced the following representatives: The Manning Packing and Supply Co., 65 S. W. 2nd Avenue, Portland 4, Oregon, representative for Oregon and the southern parts of Washington. The Hendrie and Bolthoff Manufacturing and Supply Co., 1635 17th St., Denver, Colorado, will represent the company in Wyoming, Colorado, New Mexico and western Nebraska. M. F. Hampton Co., 505 McBirney Building, Tulsa 3, Oklahoma, will be the representative in the state of Oklahoma. Hoffman Supply Co., Abilene, Texas, will represent the company in the northern Texas territory.

J. J. Walsh has been appointed district sales manager for the New York district of the Page Steel and Wire Division of American Chain & Cable Co., Inc., with headquarters at 230 Park Avenue, New York. Mr. Walsh has been associated with the company for the last 12 years.

Michael J. Devaney has been appointed assistant to manager of the Chicago district operations of Carnegie-Illinois Steel Corp., U. S. Steel subsidiary. Mr. Devaney started his steel industrial career 45 years ago and for the past 4 years has been assistant general superintendent at the plant.

The Steel Improvement & Forge Co., Cleveland, Ohio, has appointed W. E. Graves, sales manager; and R. A. B. Williams, Professional Building, Los Angeles, Calif., sales representative on drop, upset and press forgings for the Pacific Coast states.

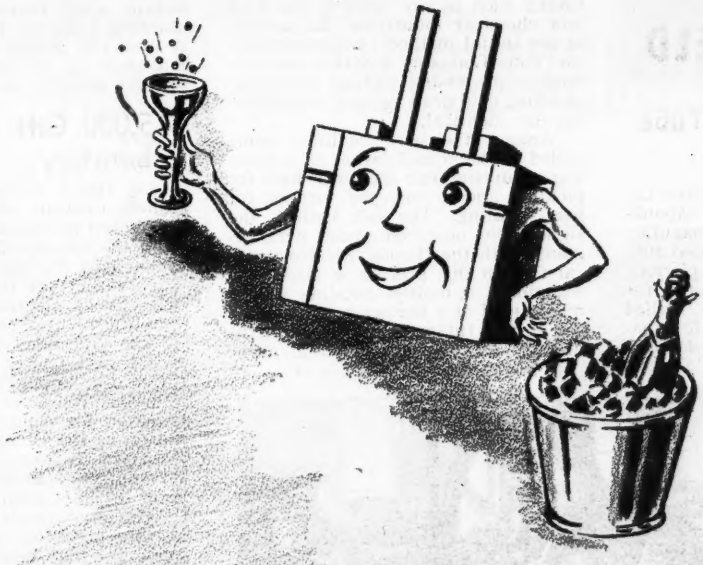
Bailey Meter Co., Cleveland, Ohio, has announced the appointment of R. E. Sprenkle as hydraulic engineer. In this capacity Mr. Sprenkle will continue to act as consultant on all problems of fluid flow and will supervise research on fluid flow. He has been associated with Bailey Meter Co. for over 20 years.

Frederick P. Huston has recently been placed in charge of the International Nickel Co., Inc., railroad developments research. Mr. Huston has been associated with the Inco Mill Products Division since June, 1940.

Elliott Company, Jeannette, Pa., has recently made the following appointments: V. H. Baker, plant manager and product engineer of Elliott Company's Lagonda division, Springfield, Ohio; G. L. Elliott, assistant to the president tube cleaner divisions; Harold W. Kealey, director of personnel, in addition to his duties as assistant secretary.

Laclede-Christy Clay Products Co., St. Louis, Mo., has recently elected Don N. Watkins to the Board of Directors to succeed A. H. Killinger. Mr. Watkins has been president of Steel Publications, Inc., publishers of Technical Steel Magazines. He also served as executive consultant to Henry J. Kaiser Co. on the construction, operations and sales.

Dr. Donald Price who has specialized in research work on wetting agents, synthetic detergents, water repellants and sulphonated oils, has been appointed technical director of Oakite Products, Inc. There he will direct the activities of Oakite's engineering and chemical staff including its research laboratory and technical service department.



DOES YOUR PLANT

have a champagne taste when it comes to coal?

Why

FAIRMONT LOW FUSION COAL?

because!

. . . it can be burned efficiently and economically in any combustion equipment properly engineered for its use.

. . . it will be available for many years to come because of its huge reserves.

. . . it has an attractive B.T.U. value when compared with that of high-priced, limited-supply premium coals.

. . . it assures competitive steam costs because of longe range planning.

Modernize your plant with equipment liberally designed to burn a wide range of coals and you eliminate the necessity for high-priced coals to satisfy that "champagne taste." Include low fusion coals in design specifications and you can utilize, with equal efficiency, a variety of coals.

FAIRMONT COAL is consistently economical for steam generation because of its lower mining cost and tremendous reserves. The investment for modernization will pay dividends promptly and will assure competitive steam costs during the entire life of the plant.

Every plant can and should have a *beer pocketbook* when it comes to steam costs. Ask us to be specific.

The Fairmont Coal Bureau has some very interesting and timely data (most of which are available for the first time) to send you on the subject of coal and its relation to equipment and power costs. These data are in "Reference Bulletin" form and will be sent promptly on request. If you'll mail coupon below we'll have an opportunity to present this important information which you should have immediately.

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Kindly place me on your mailing list to receive copies of "Coal Reference Bulletins." It is understood these will be sent FREE and without obligation.

Name .....

Company .....

Position .....

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City ..... Zone ..... State ..... P.P.E.

NEWS *from* THE FIELD

Babcock & Wilcox Tube Co. Expansion

The Babcock & Wilcox Tube Co. of Beaver Falls, Pa., is now expanding facilities to include the manufacture of atomic hydrogen welded tubing and pipe. The rotary piercing method is eminently suited for the larger diameters and heavy walled tubing such as cracking still tubes and the like, while the atomic hydrogen welded process is reported to be better suited for smaller sizes of tubing such as are used in the food and chemical industries. Regardless of the initial method of manufacture, the Tube Company facilities for subsequent processing such as annealing, pickling, cold drawing and straightening are identical.

Among the new facilities being added in the consolidation of a stainless producing unit are a salt bath for pickling and a conveyor furnace for heat treating. The salt bath is designed and operated under arrangements with the Hooker Electrochemical Co. In this process, a steel tank containing a molten alkaline salt is maintained at a temperature of about 930 F. and tubing is immersed in the molten salt, being handled in crane slings lifts. This salt, which disintegrates the refractory and acid resistant scale customarily found on stainless steel, has the advantage that it does not attack the metal and is not used up or lost except for the amount dragged out by the material.

$15,000 Gift to IIT Laboratory

Dr. Henry T. Heald, president of Illinois Institute of Technology, has announced an initial grant of $15,000 from the Ohmite Manufacturing Co. to be used for the establishment of a laboratory for the precision measurement of electrical and magnetic quantities.

The gift, came through David T. Siegel, president of Ohmite Manufacturing Co. and a trustee of Illinois Tech. It represents the initial contribution for equipping what will be known as the Ohmite Laboratory for Precision Measurements. It will be constantly expanded as new equipment becomes availabale.

The laboratory's ultimate goal is to provide precision electrical measurements for the Chicago area approaching in accuracy those of the Bureau of Standards in Washington, D. C.

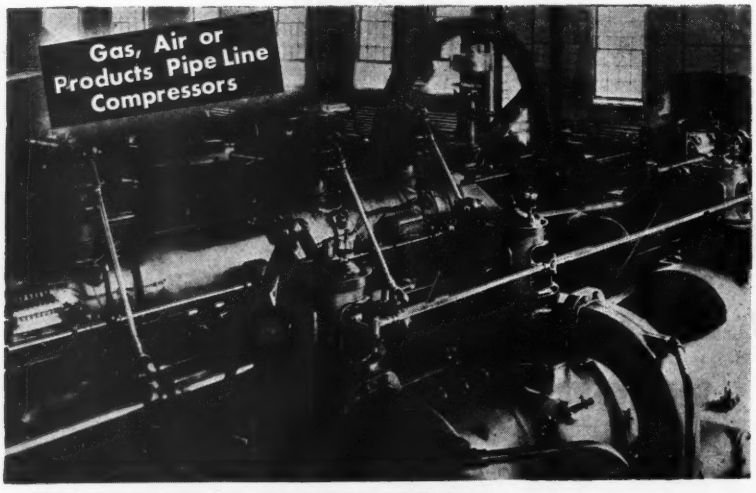
Fuel Savings Reported

At a recent meeting of the National Fuel Efficiency Council and Bureau of Mines officials in Washington, D. C., fuel savings ranging from 3 to 35 per cent in industrial plants, office buildings, schools and colleges, apartment houses, Government buildings and other commercial consumers were reported.

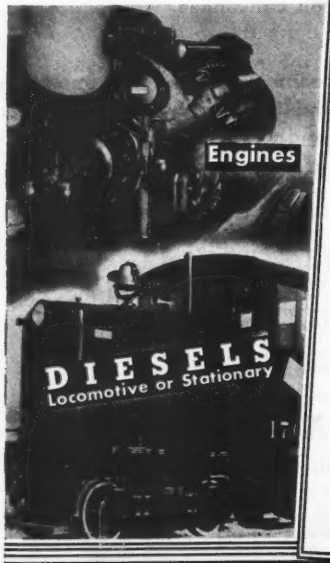
Nearly 10,000 plants throughout the country have been visited and surveyed by volunteer engineers working in the National Fuel Efficiency Program which is sponsored by private industry and the Bureau of Mines. Pledges of co-operation have been signed by operators of these plants, and a "waste chaser" has been appointed in each plant to put into use the technical information provided by the Bureau of Mines and the volunteer engineers.

Progress toward the goal to save 29 million tons of coal each year was disclosed at the meeting of the council, which is composed of some of the Nation's leading fuel and combustion engineers. Members were told that substantial fuel economies have been reported by individual plants adopting modern combustion practices at the recommendation of the programs' regional engineers, but that no overall estimate of savings can yet be made. The signing of a pledge of co-operation alone tends to encourage fuel savings, staff members pont out.

Still expanding their field organization, the directors of the National Fuel Efficiency Program now have appointed 181 area coordinators throughout the country with supervision over 5000 regional engineers, all volunteers from industry. Coordinators, in turn, have appointed 726 persons to their advisory committees. Thirty-four "quiz sheets", providing fuel-efficiency information for different types of installations, have been printed, two more are being printed, and 12 others have been prepared.



WATER PROBLEMS RESPOND TO



HAERING GLUCOSATES

FOR

CORROSION & SCALE CONTROL.

—o—

WRITE FOR

"H-O-H WATER STUDIES"

WE READ WATER

D. W. HAERING & CO., Inc.

GENERAL OFFICES:

205 West Wacker Drive, Chicago 6, Ill.

Pressure Proof Joints . . . Tight as a Weld !

GRUV-SEAL "Forged Iron" Ring Gaskets

These gaskets used at all flange connections, valve bonnet joints, and at joints where ready disassembly is a necessary requirement, reduce power losses and shut-down time for pressure lines and pressure vessels.

With Gruv-Seal "Forged-Iron" Ring Gaskets, wrench pressure molds a tight seal that stays tight.

These gaskets are manufactured by a special forging method which eliminates metal porosity and interlocks the metal fibre lines into a dense, tough structure such as is obtained by no other fabricating process. Gruv-Seal "Forged-Iron" Ring Gaskets are exact in every detail; true in diameter, circumference, and in thickness; perfectly proportioned *and machined to a fine, smooth finish.* The metal from which these are forged possesses *corrosion-resisting properties beyond those of ordinary steels.*

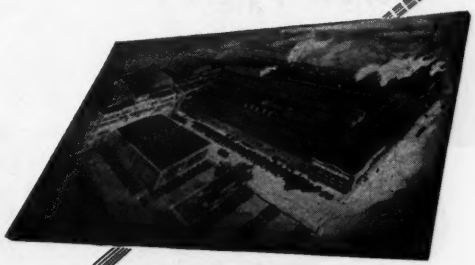
Gruv-Seal "Forged-Iron" Ring Gaskets are made in a wide range of sizes, including all standard A. P. I. sizes. New sizes are constantly being worked out as requirements occur. Write for special bulletin on Gruv-Seal "Forged-Iron" Ring Gaskets.

These gaskets are one item of the complete line of Diamond "S" Forged Boiler and Tank Accessories which includes manhole cover assemblies, handhole cover assemblies, welding street ells, welding fittings, special flanges, water column ells, welding necks, all of which are forged to close tolerances from suitable metals, and fully meet and exceed A. S. M. E. requirements for steel use in pressure vessel parts.

THE STEEL IMPROVEMENT & FORGE CO.
966 East 64th Street • Cleveland, Ohio

One purpose . . .

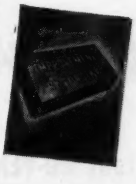
the IMPROVEMENT of Metals by Forging



Here the most modern forging and heat treating equipment is being utilized under the direction of highly skilled executives and technicians to obtain volume production of forgings for the war effort and to make available for the peace to come high quality forgings for every industrial use.

Riveter Frame Forging, formed to close tolerances. Requires no machining or finishing except drilling holes.

Reference Data Booklet presents many new ideas on forgings and their applications in many different kinds of equipment. Copies available to engineers, metallurgists and executives.

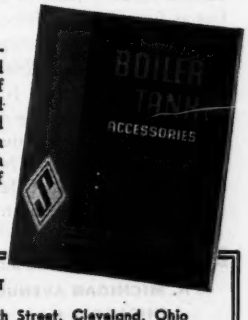


In forgings you get strength and toughness—*metal quality* developed fully—high tensile and impact strength, toughness and fatigue resistance. *Forgings assure dependable performance because they have what it takes to meet unpredictable emergencies.* Buy equipment fortified by forgings.

DROP FORGINGS

THE STEEL IMPROVEMENT & FORGE CO.
966 East 64th Street • Cleveland, Ohio

Catalog No. 10 illustrates, describes, and lists a complete line of forged steel boiler and tank accessories and contains technical data and general information about the application of such products.



THE STEEL IMPROVEMENT & FORGE COMPANY
Dept. PPE, 966 East 64th Street, Cleveland, Ohio

Please send complete information about Gruv-Seal "Forged Iron" Ring Gaskets and Catalog No. 10.

Name ..... Position .....

Company .....

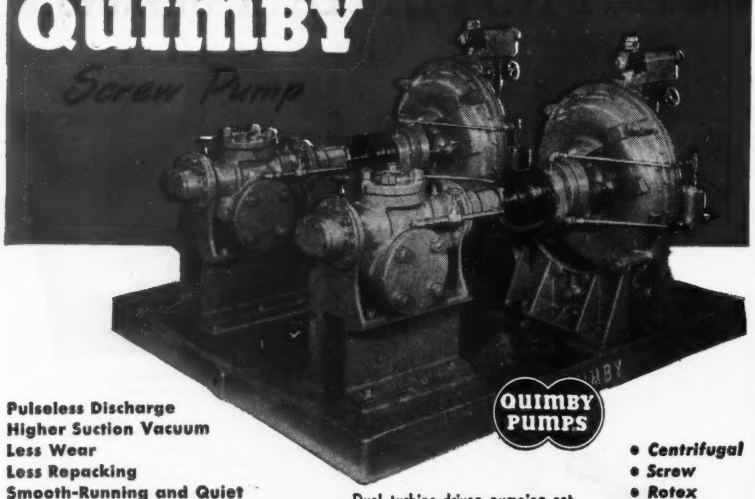
Address .....

City ..... State .....

You can burn it *Better* and *Cheaper* with a

QUIMBY

Screw Pump



Pulseless Discharge
Higher Suction Vacuum
Less Wear
Less Repacking
Smooth-Running and Quiet
Motor or Turbine Drive

Dual turbine-driven pumping set
6 HP, 1450 RPM, 15 GPM.

- *Centrifugal*
- *Screw*
- *Rotex*
- *Sump*

H. K. PORTER COMPANY, Inc.
PITTSBURGH 22, PENNSYLVANIA
QUIMBY PUMP DIVISION
340 THOMAS STREET, NEWARK 5, N. J.

WANT TO GET MORE WORK
from cookers and heaters?
...handle condensate the Stout NO-VENT way

The Stout NO-VENT Pump has been engineered for one purpose: to operate continuously and return all condensate directly back to the boiler as fast as formed, and without the use of steam traps, vents or reheating.

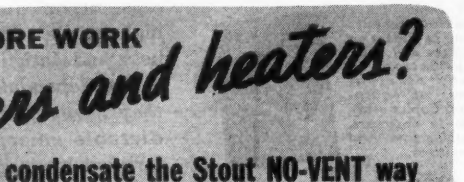
With the simplified Stout NO-VENT System the condensate is returned at temperature and pressure at which condensed. This insures better circulation and drier steam in all heating units. That's why hundreds of plants operating cookers, heaters, driers, presses, etc., not only save up to 25% in fuel, but step up their production 5% or more.

Write today for bulletin showing hook-up of Stout NO-VENT Boiler Return System, giving operating details and practical guarantee chart of saving in boiler load. Made in capacities 100 to 800 bhp, pressures to 200 lb.

Distributors will be interested in details of attractive selling franchises now being offered.

DAVID STOUT & SONS
6 N. MICHIGAN AVENUE
CHICAGO 2, ILL.

This Stout NO-VENT Outfit collects 5610 lb. of condensate per hour at 150 lb. pressure and returns it to the boiler at 366 degrees F.



Stout
NO-VENT BOILER RETURN SYSTEM

Kaiser Engineers

Henry J. Kaiser has recently announced that engineers long associated with him and responsible for the design and construction of some of the world's outstanding projects, have been organized as a permanent group known as Kaiser Engineers, with headquarters in the Kaiser Building, Oakland, Calif. This move will make available to others the engineering talents which have been responsible for the design of many of the Kaiser projects. Mr. Kaiser is president of the new organization with E. E. Trefethern, Jr., vice-president; T. M. Price, vice-president, and George Havas, vice-president and general manager. It is the policy of the company to undertake engineering work in all parts of the world.

Clarence C. Custer at the age of 74 has enlisted in the Merchant Marines for duty on ocean going vessels as 1st assistant marine engineer. Mr. Custer has been a frequent contributor of articles published in POWER PLANT ENGINEERING over a number of years. He secured his engineering experience in marine work which he left some 25 years ago, since which time he has been engaged principally as an insurance inspector.

Soren H. Mortensen, chief electrical engineer of the Allis-Chalmers Mfg. Co. has been chosen to receive the 1944 Lamme Medal of the American Institute of Electrical Engineers, which is awarded annually to members of the Institute in recognition of high achievements in the development of electrical apparatus or machinery. Mr. Mortensen's contribution to the industry is cited as his pioneer work in the development of self-starting synchronous motors and contributions to the development of large hydraulic and steam turbine driven generators.

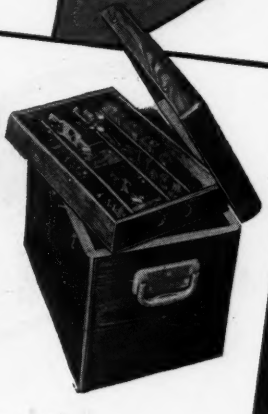
Announcement has been made by the James F. Lincoln Arc Welding Foundation, Cleveland, Ohio, of a project in the form of an award program to encourage preparation and publication of textbooks, one on machine design and another on structural design for fabrication by all processes, including welding. This project is known as the $20,000 Award Program for Textbooks Covering Machine and Structural Design for Modern Processes. The awards will range from $5000 for the first prize down to $2000 for the third prize.

The Valve Manufacturers Association has recently elected W. B. Holton, Jr., as its president. Mr. Holton is president of the Walworth Co. and since March 1943 has been Production Consultant and Head of the Valve and Fittings Industry for the War Production Board in Washington. His resignation from that position became effective on February 1 of this year.

B. R. Newcomb has recently been selected to serve on the committee on patents of the National Association of Manufacturers. Mr. Newcomb is president and general manager of the John Waldron Corp. of New Brunswick, N. J. It is the announced intention of the NAM Committee this year to continue its nationwide efforts to encourage invention and scientific progress through strengthening and improvement of the Patent System.

AS PRODUCTION MANAGER, I'M 100% IN FAVOR OF...

DEXTER VALVE RESEATING MACHINES AND CUTTERS



Here's Why

It's bad enough to lose one production man-hour these critical days — but when one of our main valves leaked badly and had to be repaired or replaced, a whole department used to quit work for hours, sometimes days.

That was before we had Dexter Valve Reseating Equipment, however. Now, one man can *reseat* a valve in a few minutes *right on the line,* and those big production time losses are a thing of the past. Our production chart shows big gains.

No more big losses in steam, air, water and oil — and resultant power losses, either. And the reseated valves are actually *better* than new, according to our engineers.

★ ★ ★

A large part of our production facilities is devoted to war work. Orders for Dexter Machines and Cutters, from firms who want this economy and efficiency, have far exceeded our non-military manufacturing facilities. Please be patient — we will deliver just as quickly as possible.

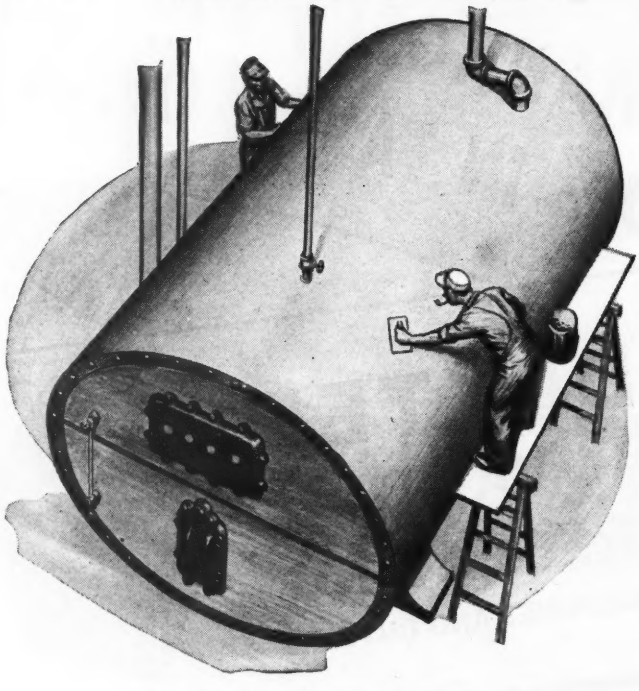
FOR GLOBE, GATE AND PUMP VALVES

What's your Valve leak problem?

Write in—today—about your valve leaks, giving make, size, type and material... water, steam, or air, and the pressure. We'll tell you what we can do to solve it, without obligation.

THE LEAVITT MACHINE COMPANY
ORANGE, MASSACHUSETTS

*CONSIDER *these 6 facts*



*when you need an insulating cement

(1) B-H No. 1 Insulating Cement is efficient over the full range to 1800° . . . because a special processing of high-temperature-resisting nodulated Baldwin-Hill *black* rockwool and other ingredients provides complete retention of the cement's physical characteristics. It will not form a homogeneous mass.

(2) B-H No. 1 Insulating Cement assures a permanent bond — whether applied on a hot surface and dried instantly, or slowly air-dried over a period of time.

(3) Rust cannot come between B-H No. 1 Insulating Cement and metal, as the cement contains a special rust inhibitor which prevents corrosion. This feature reduces costly replacements.

(4) No peeling or cracking—B-H No. 1 Insulating Cement retains sufficient elasticity to absorb normal expansion and contraction.

(5) Easily applied without skilled labor. Simply mix with water, and trowel on.

(6) 100% reclaimable up to 1200°.

Write for a practical sample and complete data.

For *one-block* insulation—at all temperatures up to 1700° F.—write for illustrated data on MONO-BLOCK.

***Address:* Baldwin-Hill Co., 577 Klagg Ave., Trenton 2, N. J. Plants in Trenton, N. J., Kalamazoo, Mich., Huntington, Ind.**

Baldwin-Hill

COMPANY

HEAT & COLD INSULATIONS

New ENGINEERING BOOKS

Occupational Accident Prevention. By Harry H. Judson and James M. Brown. Copyright 1944; 6 by 8½ in.; 234 pages; cloth cover; published by John Wiley & Sons, Inc., 440 Fourth Avenue, New York, N. Y. Price $2.75.

This book is intended to meet the needs of supervisory employees and foremen interested in industrial safety engineering and it is planned for the supervisory employee as well as for the safety director. It is not so much about safety itself as about the fundamentals in plant operation for bringing about accident prevention. Briefly it is intended to show how to obtain freedom from accidents.

The book is divided into three general sections. Following Section 1, an introduction, Section 2 covers the general subject of Improvement of Work Procedures. This includes separate chapters on Plant Housekeeping; Handling Materials; Maintenance Problems; Prevention of Falls; Hand Tools; Employee Training and the like. Section 3 deals with Improvement of Plant, including chapters on Accident Causes and Sources; Layout and Arrangement; Illumination; Guarding; Electrical Conditions, etc. Section 4 deals with Safety Activities with chapters on Compensation Laws; Organization; Inspections; Reports and Records; First-Aid Facilities; Psychology and Safety; Standards and Codes; and Safety Equipment.

Appendix I gives the American Standard Method of Compiling Industrial Injury Rates, while Appendix II gives data on ten Sound Slide Films covering the subject of safety.—C. R. E.

Thermodynamic Charts, also Special Tables for Turbine Calculations. By Frank O. Ellenwood and Charles O. Mackey. Copyright 1944, 2nd Edition; 8 by 11 in.; 46 pages; cloth cover; published by John Wiley & Sons, Inc., 440 Fourth Avenue, New York, N. Y. Price $2.75.

This new edition embodies corrections that have been noted in the 1st edition published in 1939 and also some modifications and additions. For example, Plates 8 and 9 have been redrawn to include the pressure scale for the saturated liquid and some of the volume lines have been eliminated to make the temperature scale easier to read. To enable enthalpy-volume charts for steam to be used more conveniently, the page numbers of the adjoining plates have been added on the margin of each plate. An entirely new form of chart has been made for steam and water mixtures having qualities less than 80 per cent.

The material included in the new edition covers the following: Note regarding enthalpy; index chart for steam; steam charts; water charts; low quality steam chart; ammonia charts; Freon—12 charts; psychrometric charts; examples of the use of the charts, tables for corrections of barometric readings; jet velocity from nozzles; squares of numbers and common logarithms.—C. R. E.

"Certainly we're ready to talk elevators"...

DURING the past several years, the manufacturing facilities of the Otis Elevator Company have been devoted largely to the production of a great volume of specially designed elevators and precision equipment for a number of vital war requirements.

And, as long as the war lasts, a large part of these facilities will continue to be devoted to the production of war goods.

Right now, however, the Otis Elevator Company is in a position to help you *plan for your post-war elevator needs.*

Your Otis representative is ready to serve you. He is available to analyze fully your elevator problems and to make recommendations concerning the equipment which will be best suited to your post-war requirements.

By planning now, you will be assured that a minimum of time will be lost in getting your required equipment in production after war restrictions have been removed.

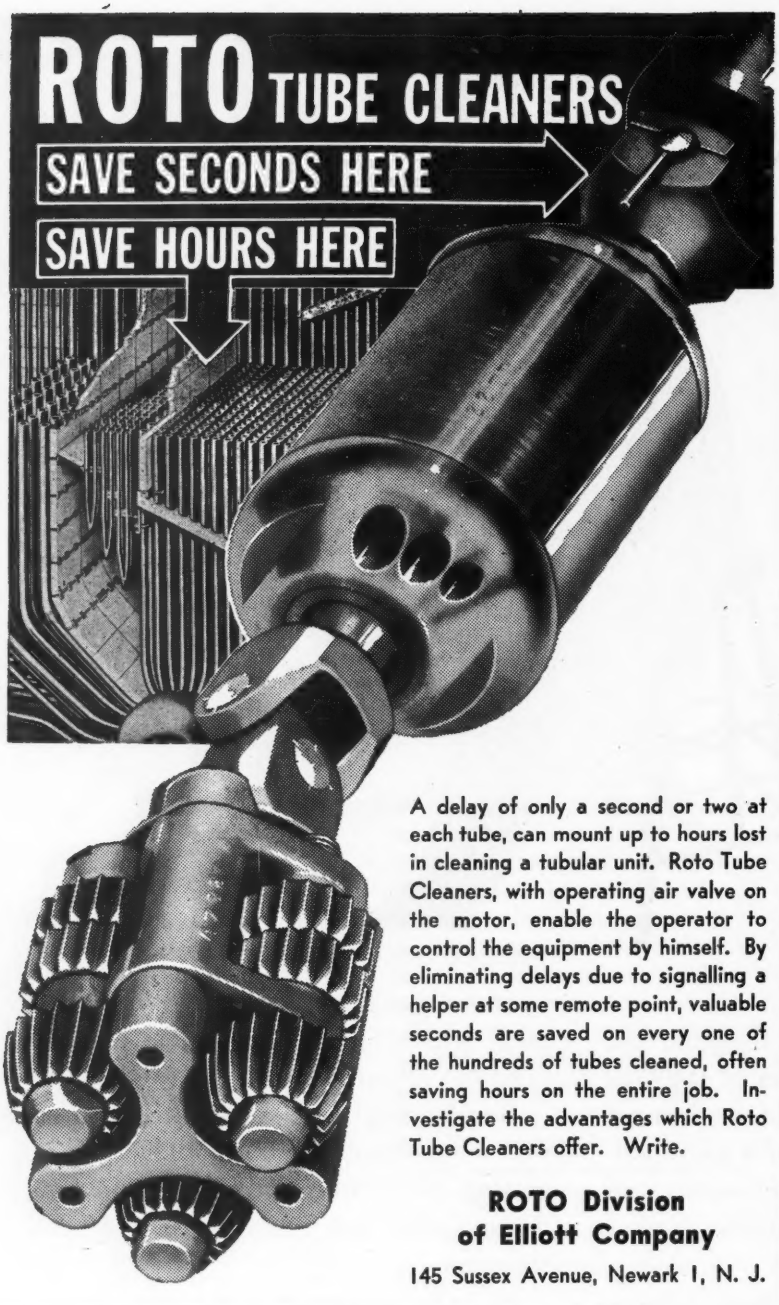
So, to be certain of the last word in vertical transportation for present or proposed office buildings . . . for hospitals, hotels, factories, or warehouses, call your Otis representative *today.*

Otis ELEVATOR COMPANY
OFFICES IN ALL PRINCIPAL CITIES

ROTO TUBE CLEANERS

SAVE SECONDS HERE

SAVE HOURS HERE



A delay of only a second or two at each tube, can mount up to hours lost in cleaning a tubular unit. Roto Tube Cleaners, with operating air valve on the motor, enable the operator to control the equipment by himself. By eliminating delays due to signalling a helper at some remote point, valuable seconds are saved on every one of the hundreds of tubes cleaned, often saving hours on the entire job. Investigate the advantages which Roto Tube Cleaners offer. Write.

ROTO Division of Elliott Company

145 Sussex Avenue, Newark 1, N. J.

CLASSIFIED ADVERTISING

SALESMEN AND AGENCIES

WANTED: Salesman to manage district office of established manufacturer selling nationally advertised power plant equipment. College training, preferably in engineering, experience in power plant work or sale of power plant equipment, desirable. Age 30-35. Location Cincinnati. Address Box 1474, Power Plant Engineering, 53 W. Jackson Blvd., Chicago 4, Ill.

AGENTS—We want men to handle a time-tested process Condensate Return System which we sell on Guaranteed quick payout saving basis with liberal compensation. Address Box 1461, Power Plant Engineering, 53 W. Jackson Blvd., Chicago 4, Ill.

SALES ENGINEER offers to represent good line power plant equipment on exclusive agency basis. Has thorough experience steam and power generating equipment and accessories. Good sales record and contacts in Metropolitan New York area. Address Box No. 1469, Power Plant Engineering, Graybar Bldg., New York, N. Y.

BUY MORE WAR BONDS NOW

CLASSIFIED ADVERTISING

HELP WANTED

STEAM PLANT SUPERINTENDENT

To take complete charge of operation of new high pressure oil-fired boiler plant and steam distribution system to process. Must know water treatment for boiler feed and handling of high temperature condensate system.

BOX 1475
Power Plant Engineering
53 W. Jackson, Blvd.
Chicago 4, Ill.

Designing Engineer

Capable of developing and designing mechanical products, with knowledge of research and testing procedure; experience in power plant specialty field desirable; excellent opportunity with a well-known established manufacturer doing business on a national scale. Please furnish complete reference and qualifications in first letter.

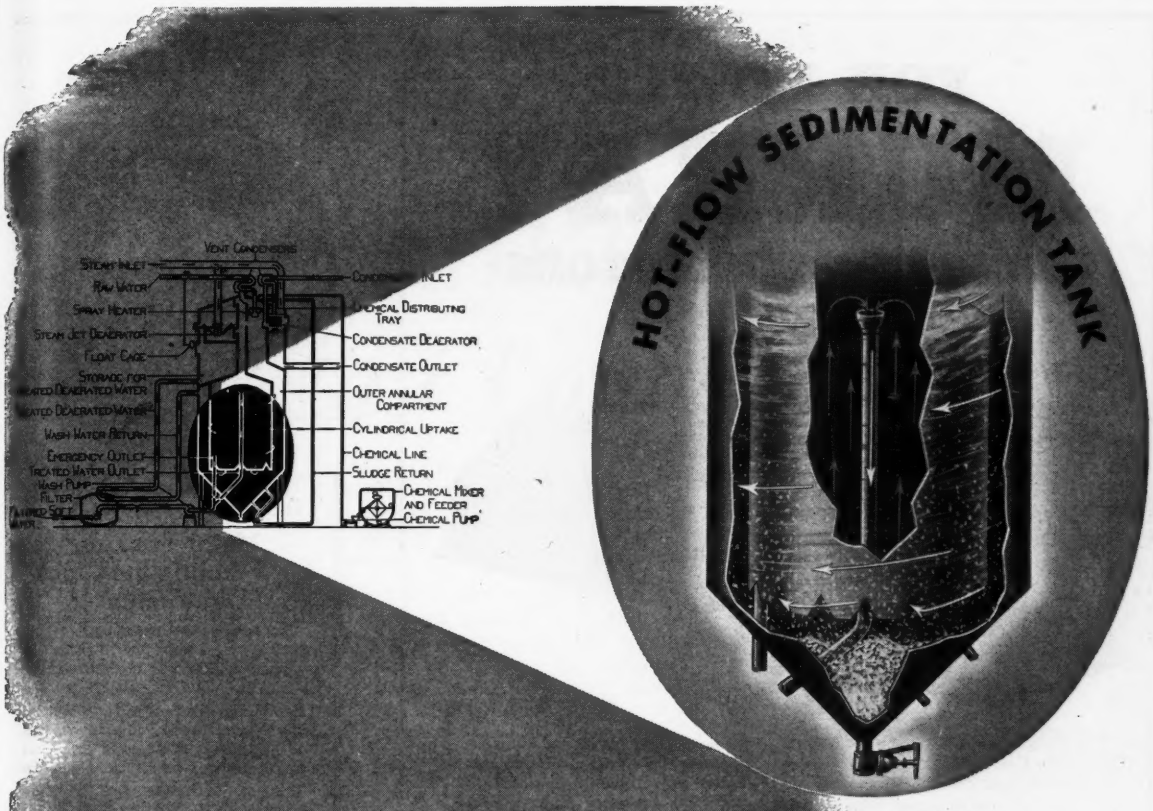
American District Steam Co.,
North Tonawanda, N. Y.

WANTED—In modern large meat packing plant one architectural engineer, one mechanical engineer for general designing, and one mechanical engineer to be assistant power plant engineer. Three years' minimum experience. Address Box 1467, Power Plant Engineering, 53 W. Jackson Blvd., Chicago 4, Ill.

WANTED — MECHANICAL ENGINEERING graduate for permanent position in results department of a large steam generating station. Station is operated by a public utility corporation located in the East. Statement of Availability is required. Write Box 1473, Power Plant Engineering, 53 W. Jackson Blvd., Chicago 4, Ill.

POSITION WANTED

POSITION WANTED: Stationary engineer with many years experience desires permanent connections with progressive industry. Experience includes plants with generating capacity up to 250,000 pounds per hour, and operating at 650 Psi, 300 deg. F. superheat. Experience also includes electrical generation and refrigeration. Age 42. Address Box 1476, Power Plant Engineering, 53 W. Jackson Blvd., Chicago 4, Ill.



Two Compartments of Equal Volume and Cross Sectional Area

HOT-FLOW SOFTENERS FOR BOILER FEED-WATER TREATMENT . . . . .

PLUS VALUE No. 1 SEDIMENTATION TANK DESIGN

EQUAL VOLUMES: The water must spend half its retention time traveling down the outer compartment—so chemical reactions are completed and solids precipitated long before the water turns upward into the inner compartment.

EQUAL CROSS SECTIONS: There is no variation in velocity of forward travel from inlet to outlet—not even at the point of change in direction of flow.

Thus, this design feature establishes an operating condition conducive to maximum solids separation and sedimentation. The result is an ample volume of properly settled, relatively clear water always ahead of the filters, and this

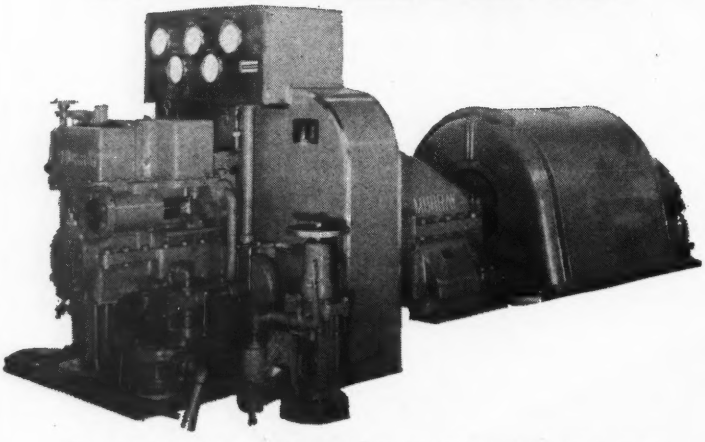
- **permits 350% overload when backwashing**
- **permits full recovery of wash water**
- **increases the length of filter runs**
- **increases the life of filtering media**
- **reduces operating attention required**
- **eliminates the need for any coagulant**
- **assures high clarity of filter effluent.**

INFILCO

INFILCO INCORPORATED

325 WEST 25th PLACE • CHICAGO 16, ILL.

FOR POWER
MURRAY
TURBINE GENERATORS



Do you need additional POWER? Are you losing POWER by allowing steam to go through reducing valves to process? Have your plant changes thrown your plant heat balance off from the way it should operate?

Correct the situation with a MURRAY STEAM TURBINE GENERATOR SET, properly designed for your present operating conditions. Whether your plant needs a straight non-condensing unit, or one designed for bleeder or mixed pressure operation, MURRAY has already built a similar machine, now in satisfactory operation for a number of years, among the numerous machines furnished industrial and municipal plants.

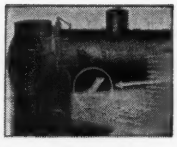
There is a MURRAY sales representative near you, ready to serve you, with information or guidance in planning.

MURRAY also produces:

Multistage and single stage Mechanical Drive Turbines
Vertical single stage turbines
High Speed Reduction Gears
Steam Boilers

MURRAY IRON WORKS COMPANY
BURLINGTON, IOWA
Builders of Steam Power Equipment for Three Quarters of a Century

"Boiler Repairs Reduced 75%"
writes user of **NATIONAL GIRTH SEAM PROTECTOR**

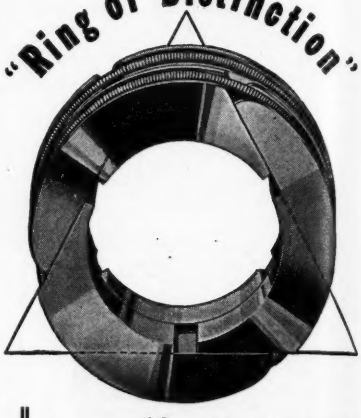


We have been using the National Girth Seam Protector for several years and they certainly do the job. . . . Have reduced our boiler repairs at least 75% since using these protectors, one of the best investments we ever made.
Von Platen-Fox Co.
Iron Mountain, Mich.

You, too, will find the National Girth Seam Protector saves trouble and money by preventing leaks and fire-cracking on new or old seams in boilers. Sections consist of wedge nut, cap screw metal lug and refractory covering; are easily attached. We can make immediate deliveries. Send for descriptive bulletin.

NATIONAL BOILER PROTECTOR CO., 740 REIBOLD BLDG., DAYTON, OHIO

"Ring of Distinction"



Install FRANCE
Metal Packing for "'Round-the-Clock" Production

The renewal of ordinary packing every few weeks or months increases horsepower and production costs.

Minimum friction is encountered with France Metal "Ring of Distinction" Packing. No undue force can be exerted on rods or stems by tightening the stuffing box stud nuts. The rings are free to float in the case that retains them and are held to the rod or stem with a greater spring having minimum tension.

The result is tight "full-flating," trouble-free performance for years. Prompt delivery assured.

FREE

44-page Catalog of useful and valuable information. Write for your free copy of Catalog M-5, with facts on

- Packing Designs for Any Service
- Installation Procedure
- Methods of Lubrication
- Pressures and Temperatures
- Oil Return and Stripping Rings
- Handy Reference Tables

Request France Engineers to analyze your packing requirements. There is a representative close at hand.

THE FRANCE PACKING COMPANY
Tacony, Philadelphia 35, Penna.
Branch Offices in Principal Cities

Original **FRANCE METAL PACKING**

[PUMP TIPS FROM ALLIS-CHALMERS—ONE IN A SERIES]

How to make WEARING RINGS Last Longer . . .

ANY NEW PUMP you buy is guaranteed to deliver its rating in capacity and head. But whether it *retains* its actual capacity depends to a great extent on the condition of its wearing rings. For when rings are worn thin, liquid leaks through the enlarged clearance between impeller and casing — seriously reducing capacity.

One of the major causes of excessive ring wear is misalignment. So serious can it be, that Allis-Chalmers engineers were led to develop, for many applications, the "Electrifugal" pump — in which *both* impeller and motor are mounted on *one* shaft and in *one* frame. This *unit-design* prevents parts in the pump's closely fitted body from getting out of "kilter" . . . helps you get longer life out of wearing rings.

However, regardless of whether you have a unit-design or separately coupled pump and motor, here are a few tips which will help you get longer wear from rings in your pumps . . .

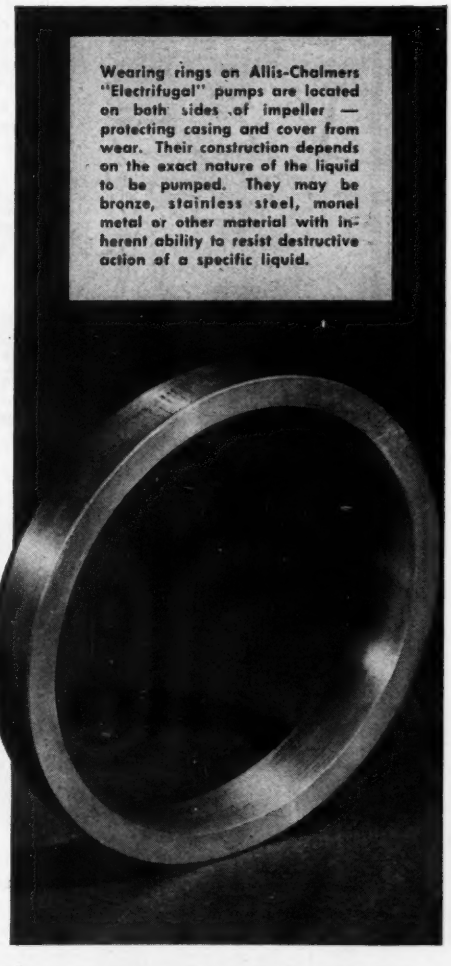
▸Never allow a pump to run dry — either through lack of proper priming when starting, or through loss of suction when operating. Remember . . . water is a *lubricant* between rings and casing.

▸Examine wearing rings at regular intervals. When new, rings in the smaller size, more commonly used pumps should have a diametrical clearance of about 0.006 to 0.008 inch on cold liquid service, and about 0.010 to 0.012 on hot liquid service. When ring clearance becomes 0.020 to 0.030 inch on the diameter it is more economical to replace rings than to pay for power lost in leakage through them.

▸Gritty liquid or foreign matter in liquid accelerates ring wear. If condition exists, provide intake end of suction piping with a suitable screen to filter out abrasive materials.

▸Watch pump alignment. Excessive strains from suction or discharge piping can and do distort casing. Wearing rings protect pump from serious damage in this event by themselves taking the wear. However, *before* installing new rings, be sure to check into the *source* of distortion.

▸Send for your *free* copy of "Handbook for Wartime Care of Centrifugal Pumps". This valuable booklet applies to *all* makes of pumps; contains *no* advertising. Contents include: tables of friction losses; guide to locating trouble; wartime maintenance schedule. ALLIS-CHALMERS MFG. CO., MILWAUKEE 1, WISCONSIN. A 1756

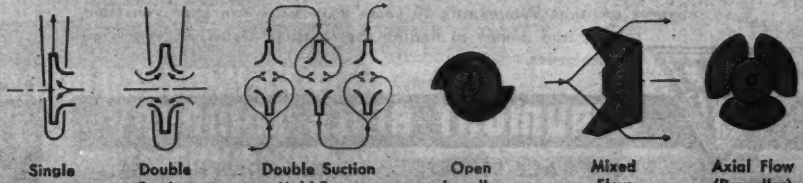


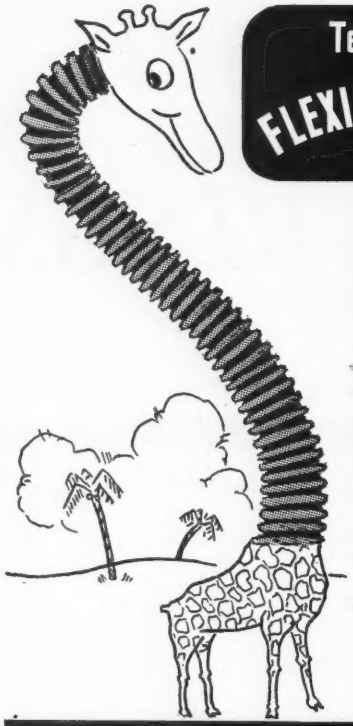
Wearing rings on Allis-Chalmers "Electrifugal" pumps are located on both sides of impeller — protecting casing and cover from wear. Their construction depends on the exact nature of the liquid to be pumped. They may be bronze, stainless steel, monel metal or other material with inherent ability to resist destructive action of a specific liquid.

♪ *Tune in the Boston Symphony, Blue Network, every Saturday at 8:30 pm, EWT.*

ALLIS-CHALMERS PUMPS

Allis-Chalmers builds all types and variations of pumps shown at right. Capacities from 10 to 150,000 gpm—heads to 2500 lbs.





Tell us about your FLEXIBLE PIPING PROBLEMS

Our engineers will be glad to put at your disposal their experience in helping answer hundreds of tough problems on handling of oils, chemicals, refrigerants, gases, air, steam, and other fluids where expansion and vibration are present.

The marked ability of ECLIPSE Seamless Metal Hose to withstand punishing heat and jarring comes from its deep parallel sidewall corrugations which combine *maximum flexibility* with *long working life.* Steel Hose can be produced up to 40 in. I. D. Metal Hose is made in two degrees of pitch, normal and close.

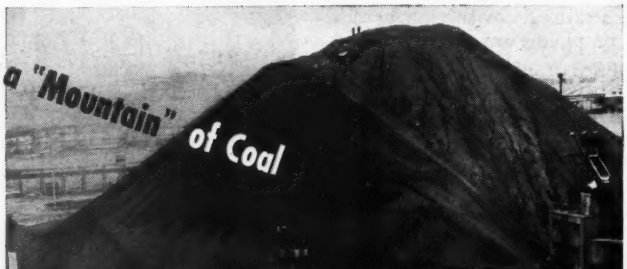
New Bulletin H-201 contains helpful handbook data on metal hose applications — ask for free copy.

THE INVISIBLE CREW — Precision Equipment — Bendix — AVIATION CORPORATION

Dept. 19—Phila. Div.—Philadelphia, Pa.

ECLIPSE Seamless METAL HOSE

Handling a "Mountain" of Coal



• One industrial plant increased its coal-pile depth from 48 to 116 feet, and boosted pile capacity from 39,000 to 150,000 tons in limited space. Although probably the highest coal pile in the world, fire hazard is actually reduced because pressure within the pile minimizes the air content.

To accomplish this, Beaumont engineers installed an aerial bridle system suspended from three 85' towers with the tail block position remotely controlled from the operator's station on the previously installed Beaumont cable drag scraper system.

Although your coal storage problem may not be as difficult as this one, chances are that Beaumont's 40 years' experience can save you time, trouble and money in finding the solution. Write outlining your requirements.

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1503 RACE STREET PHILADELPHIA, PA.

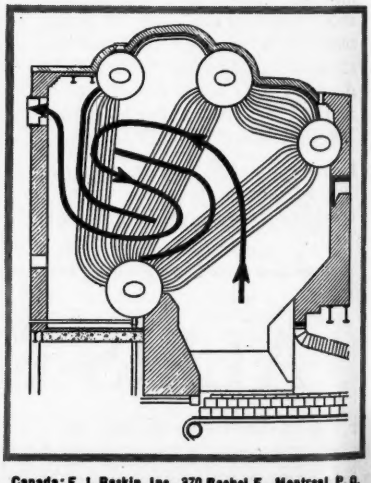
DESIGNERS • MANUFACTURERS • ERECTORS OF COAL AND ASH HANDLING SYSTEMS

Only ENCO BAFFLES offer you all these advantages

These important fuel-saving, maintenance-reducing features are obtainable with Enco boiler baffles — *and only with Enco baffles.*

- **Streamlined gas flow**
- **Uniform gas flow**
- **Elimination of bottle necks**
- **Reduced draft losses**
- **Higher heat transfer**
- **Cleaner heating surfaces**
- **Less use of soot blower**
- **Special provision for expansion**
- **Easy tube replacement**
- **Adaptable to any water-tube boiler, fired by any fuel**

Each application is designed on the basis of more than a quarter century of experience in this specialized branch of power engineering. Installations are made by skilled mechanics.



Canada: F. J. Raskin, Inc., 370 Rachel E., Montreal, P. Q.

THE ENGINEER CO.

Enco 75 West St. New York 6, N. Y.

ZURN *Fluid Handling* EQUIPMENT

protects you from pipe line grief

Pipe line grief is unpredictable, involves slow-downs and shut-downs. Zurn Fluid Handling Equipment Engineering Service provides protection all the time and under every service condition for all types of pumps, traps, regulators, aspirators, injectors, control equipment and valves. This engineering service, backed by over 40 years of technical experience, utilizes a wide range of Fluid Handling Equipment units to meet ever-changing requirements of the process industries, industrial and power plants. Zurn Fluid Handling Equipment is available in metals which are corrosion-resistant, and which provide special flow characteristics. Zurn Fluid Handling Equipment meets A. S. M. E. requirements for metals used in pressure vessel parts and every unit is thoroughly tested. Ask a Zurn Fluid Handling Equipment Engineer about how to keep pipe lines flowing at full capacity continuously.

J. A. ZURN MFG. CO.

Industrial Division • **ERIE, PA., U. S. A.**

DUPLEX STRAINER
Vertical Type

"Y" STRAINER

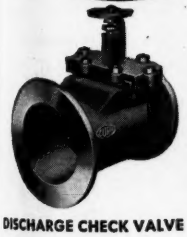
DUPLEX PIPE LINE STRAINERS for use where continuous operation and maximum flow are required; include Duplex Vertical Chamber Type Strainer for high or low pressures, and Duplex Horizontal Tube Type Strainer for low pressure.

"Y" PIPE LINE STRAINERS: Available with flange, I. P. S. threaded or butt-weld connections. Angle Type High Pressure Pipe Line Strainer for vapor, steam or gas service also available.

PRESSURE AND FLUID LINE STRAINER FOR HIGH OR LOW PRESSURES: 180° and 90° straight through and offset types; both types with bolted covers and flanged connections; cleanout plugs permit blow-down cleaning.

PRESSURE AND FLUID LINE STRAINERS

ZURN FLUID HANDLING EQUIPMENT INCLUDES



DISCHARGE CHECK VALVE

DISCHARGE CHECK VALVES: Protect against fouling of pumps and equipment tied into discharge lines carrying steam, sludge, waste water and other wastes in gravity flow installations; available in 180° straight types; 105° and 90° angle types, with or without manual control.

SOLIDS INTERCEPTOR for capturing particles of plaster, plastics, metal chips, glass, grinding compounds, and other solids which damage valves and operating equipment, or clog drains. Interceptors for lint, hair, threads and similar substances also available.

SAFETY VENT

SAFETY VENTS are vapor valves for venting tanks and processing vessels containing inflammable liquids and vapors; provide protection against fire and explosion; flange, I. P. S. threaded, or butt-weld connections.

INTERCEPTORS FOR WAX, GREASE, FATS AND OTHER LOW DENSITY INSOLUBLES: Prevent contamination of sewage outlets; also prevent drain clogging. Volatile Liquids Intercepting Drains for oils, gasoline, naphtha, etc., to safeguard against explosion and fire, also available.

SOLIDS INTERCEPTOR

GREASE INTERCEPTOR

Duplex Strainers for high and low pressures; Pressure and Fluid Line Strainers; "Y" Strainers; Safety Vents; Discharge Check Valves; Remote Valve Control Assemblies; Interceptors for Wax, Grease, Fats, and other low density insolubles; Volatile Liquids Intercepting Drains; Solids Interceptors and Lint Interceptors. Zurn Catalog No. 45 illustrates, describes and gives dimensional data on this equipment. Attach coupon to your letterhead and mail today for your copy. Zurn Products also include a complete line of Roof Drains, Floor and Area Drains, Hydrants, and Street Washers, to assure an efficient and protected drainage system for all types of buildings and areaways. Literature available upon request.

Ordnance Division

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for INDUSTRIAL AND POWER PLANTS, PROCESS INDUSTRIES

J. A. Zurn Mfg. Co., Dept. PPE, Erie, Pa., U. S. A.

Please send me copy of Zurn Catalog No. 45 on Fluid Handling Equipment.

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Company _____

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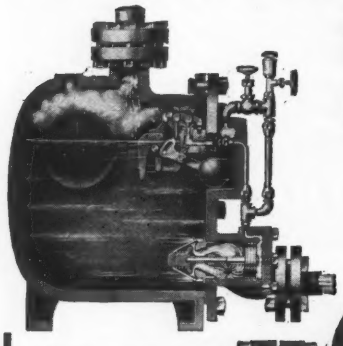
Form No. 45-47

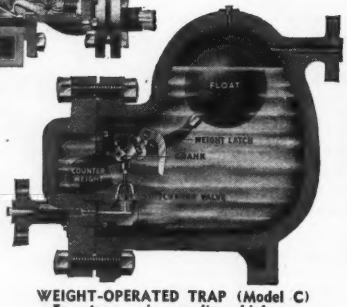
Nicholson...



TRAPS YOU CAN TRUST

FOR

High Pressures



PISTON-OPERATED STEAM TRAP—Positive, instantaneous, for pressures to 650 lbs. Non-wire drawing discharge valve. Working parts of stainless steel. Smaller size; larger orifices; faster discharge.

WEIGHT-OPERATED TRAP (Model C)—For steam, air, gasoline; high-pressure (to 1500 lbs.). Fast, automatic, intermittent, water-sealed discharge valve; larger capacity.

Featuring exclusive designs that assure faster, positive drainage, Nicholson Steam Traps are made for nearly every power and process purpose.

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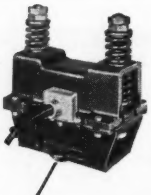
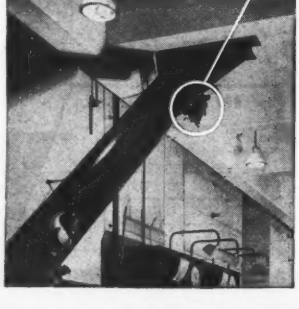
W. H. NICHOLSON & CO. 160 OREGON ST. WILKES-BARRE, PA.

Valves • Traps • Steam Specialties

DO YOU LOSE TIME— POWER— and MONEY

because of arched and clogged coal bins, hoppers and chutes?





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"Pulsating Magnet"

ELECTRIC VIBRATORS

with Adjustable Power Assure

FREE FLOWING COAL

Bins, Hoppers and Chutes

Eliminate costly coal stoppages, by preventing "arching-over" and "hanging-up."

Available in eight sizes—from a little 4 lb. model up to a big 500 lb. model.

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Your Blueprint for

MORE POWER

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OAKITE CLEANING

...Evaporative Condenser Coils Kept Scale-Free!

UNLESS formation of lime scale on the exterior coil surfaces of evaporative condensers is prevented by proper treatment of spray water, you are likely to run into trouble . . . particularly in hard water areas. Heat transfer efficiency will be seriously impaired.

Use this corrective treatment . . . introduce Oakite Composition No. 82 in spray water. It will reduce formation of hard scale on coil surfaces . . . only a soft slush will form that is easily removed by hose rinsing.

DIGEST Gives Data!

New Power Plant Digest contains helpful data for removing scale already formed or for the cleaning of inside coil surfaces. Write for your FREE copy today.

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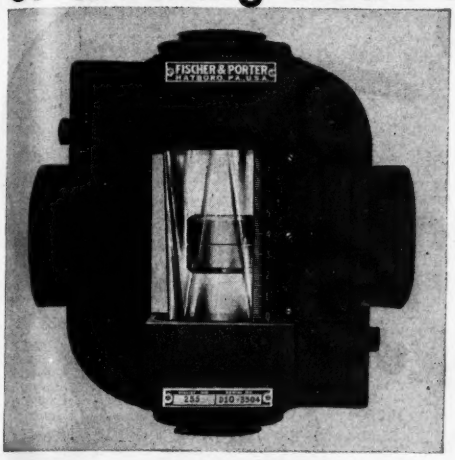
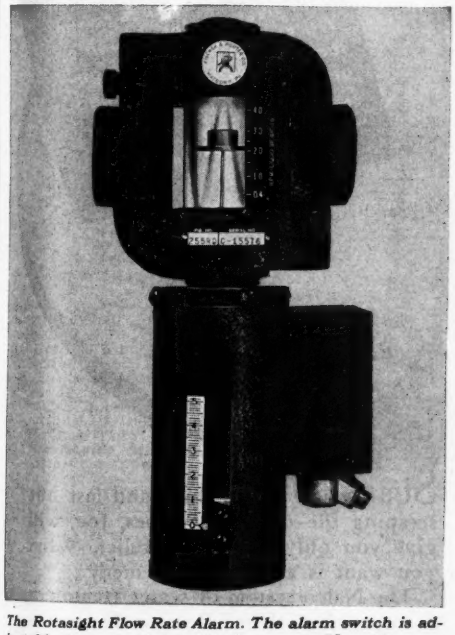
Specialized cleaning
MATERIALS & METHODS FOR EVERY CLEANING REQUIREMENT

The ROTASIGHT offers a positive, inexpensive way of checking flows to bearings and water seals!



The Rotasight Flow Rate Indicator. The position of the float tells exactly how much flow is passing.



The Rotasight Flow Rate Alarm. The alarm switch is adjustable to any point in the flow range. More than one alarm switch can be furnished if desirable.

IT is no longer necessary for you to depend upon guesswork in measuring oil flow to lubricated bearings or for maintaining water flow to water seals or cooling jackets. With the Rotasight, you can tell at a glance the exact rate of oil or water that is flowing. Furthermore, it is so close in price to the ordinary "look glass" that it is a practical purchase for the protection of expensive power plant and process equipment.

The Rotasight is a small rotameter with a new and ingenious precision glass metering tube, which has V-shaped flutes formed in it. ***The float inside the metering tube responds to flow rate changes only***—it tells exactly how much is flowing and indicates when the flow rate gets too low for safety or too high for economy. It can also be equipped with a self-contained alarm, so that you don't even have to watch it to learn when the flow has reached the danger zone.

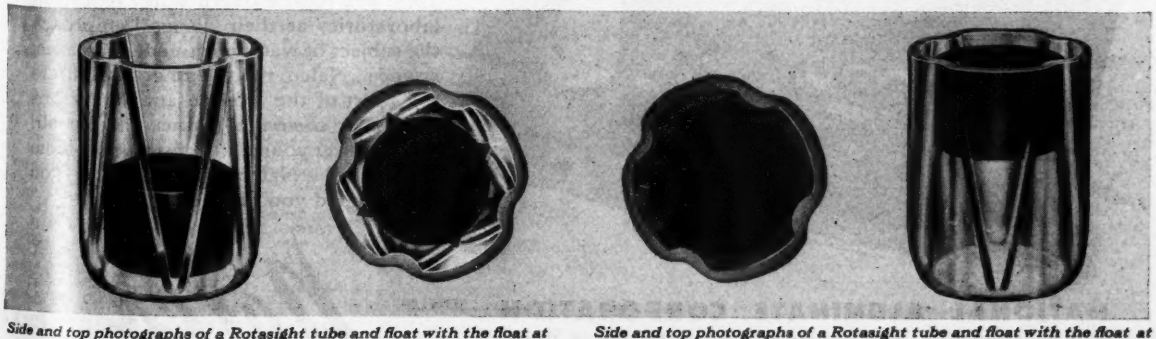
The Rotasight is cast in iron or bronze in sizes from ¼ inch to 2½ inches inclusive, for flows as high as 60.0 G.P.M. of water or 135.0 C.F.M. of air. It is compact, inexpensive and positive in its flow rate indication. Many industrial plants are finding it invaluable for checking flows of oil, water and chemicals. One large user wrote recently to us as follows:

"We are using the Rotasight to measure cooling water to ignitron tubes. Our experience with this new type of meter has been very excellent. There is nothing else available on the market to compete with it in price, compactness, ease of installation and maintenance."

Full details about the Rotasight, including principle of operation, design, dimensions, applications, capacities and prices, are given in our new catalog 92-C. We will gladly send you a copy without further obligation—right now is the time to write for it.

FISCHER & PORTER CO.

5904 County Line Road, Hatboro, Pa.



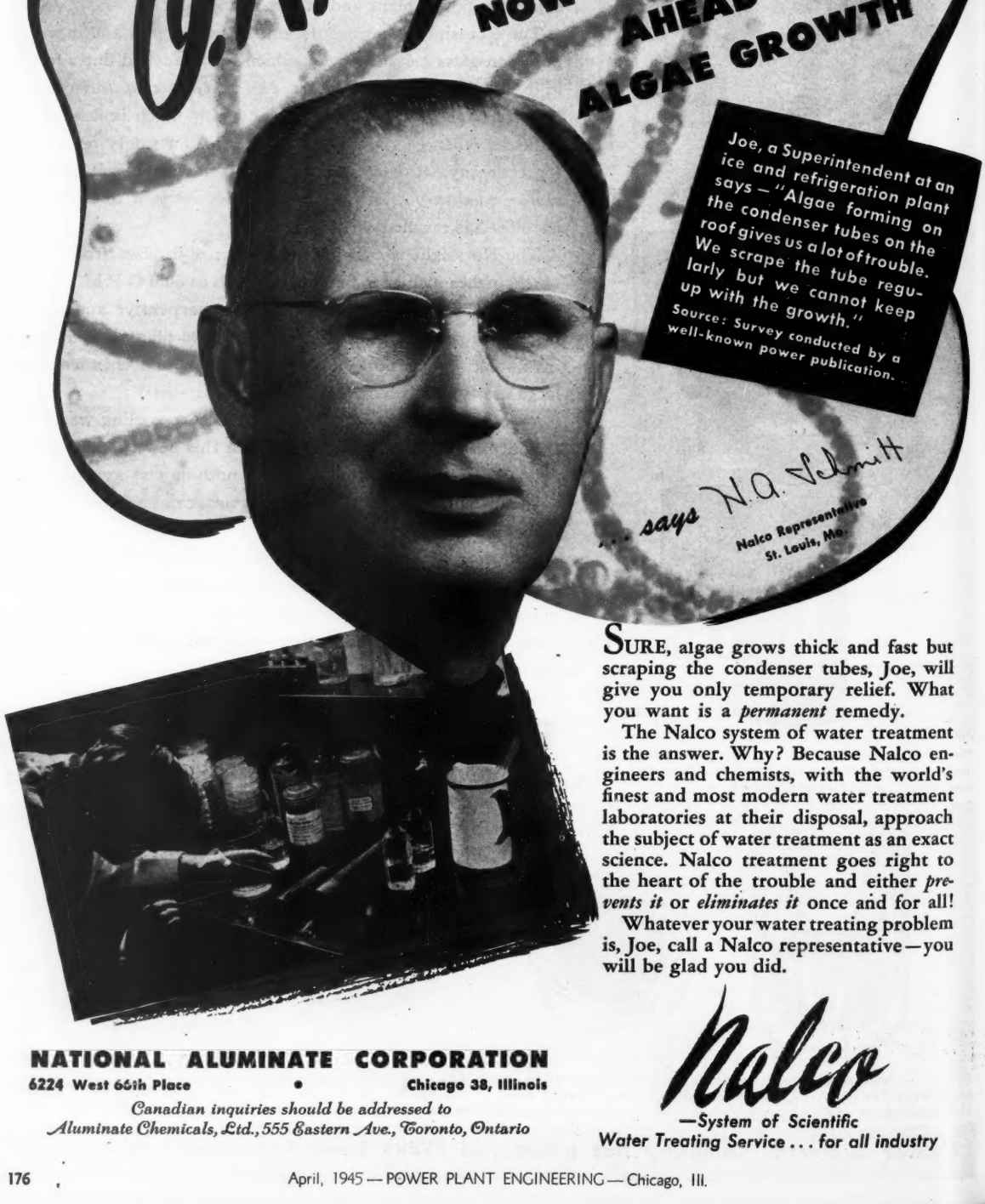
Side and top photographs of a Rotasight tube and float with the float at low position. The red in the top view indicates the size of the flow area at this position of the float.

Side and top photographs of a Rotasight tube and float with the float at the high flow position. The red in the top view indicates the size of the flow area at this position of the float.

Fischer & Porter Company has pioneered EVERY basic Rotameter improvement!

O.K. Joe—

NOW YOU CAN KEEP AHEAD OF ALGAE GROWTH



Joe, a Superintendent at an ice and refrigeration plant says—"Algae forming on the condenser tubes on the roof gives us a lot of trouble. We scrape the tube regularly but we cannot keep up with the growth."

Source: Survey conducted by a well-known power publication.

... says N.A. Schmitt
Nalco Representative
St. Louis, Mo.

SURE, algae grows thick and fast but scraping the condenser tubes, Joe, will give you only temporary relief. What you want is a *permanent* remedy.

The Nalco system of water treatment is the answer. Why? Because Nalco engineers and chemists, with the world's finest and most modern water treatment laboratories at their disposal, approach the subject of water treatment as an exact science. Nalco treatment goes right to the heart of the trouble and either *prevents it* or *eliminates it* once and for all!

Whatever your water treating problem is, Joe, call a Nalco representative—you will be glad you did.

NATIONAL ALUMINATE CORPORATION
6224 West 66th Place • Chicago 38, Illinois
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Nalco
—System of Scientific Water Treating Service . . . for all industry

HELPFUL BULLETINS

Answers to many operating and maintenance problems will be found in these new bulletins and catalogs. List paragraph numbers of those you want on coupon below, detach and mail.

BOILER PLANT

1 **Forward Moving Grate Stoker**—New catalog describes construction and advantages of Detroit RotoGrate stoker in which the grates move forward slowly and continuously discharge the ash at the front. Gives interesting pictorial review of recent installations of this equipment. Detroit Stoker Co.

2 **Low Head Bent Tube Boiler**—The Vogt low head, bent tube type boiler —especially suitable for plants having moderate processing, power or heating loads—is described in 18 pg catalog. Also shows sectional drawings of many installations of this boiler. Henry Vogt Machine Co.

3 **Heaters and Coolers**—A new, 12 pg, two color Bulletin No. 35-76B on Adsco Heaters and Coolers includes three new types with dimensions, capacity tables and list prices on units suitable for use as instantaneous heaters, condensate coolers, preheaters, fuel oil heaters, etc. American District Steam Co.

4 **Coal Crusher Data**—New 40 pg Jeffrey Catalog No. 784 describes its line of crushing equipment for all mines and industries using coal. Shows types, sizes, capacities, space required and the complete range of product sizes. The Jeffrey Manufacturing Co.

5 **Immersion Type Steam Tank Heater** —Bulletin No. 451—just issued—describes a new steam tank heater, that speeds the unloading of materials whose viscosity can be lowered by heating, gives dimensions and weights of heaters for use with tank cars and trucks. The Brown Fintube Co.

6 **New Spreader Stoker**—Bulletin No. 441-S describes the newly introduced J & J spreader type stoker, featuring: a leak-proof, dust-tight coal feeder—a combination mechanical-pneumatic coal distributing system that distributes lump and fines to all parts of the grate area—air cooling of all parts—easy accessibility. The Johnston & Jennings Co.

ELECTRICAL

7 **Connecting Devices**—Howard B. Jones Co., 32-pg catalog No. 14 describes complete line of multicontact plugs and sockets, terminal strips, fuse mounts, etc. Dimensions of items are included.

8 **Germ Killing Light Folder** — Illustrated Folder No. 800-45 answers the most frequently asked questions on the subject of Air-Disinfection for personal protection. Special fixtures are listed for wall, ceiling and floor mounting. The Edwin F. Guth Co.

9 **Gearmotor Handbook** — Booklet B-3218 shows how gearmotors cut power transmission losses, save installation time and expense. Includes application details and other handbook data. Westinghouse Electric & Mfg. Co.

10 **The A B C Of Electronic Heating**—This 16 pg handbook contains a brief record of the development of electronic heating—explains the principle of its operation—describes the two chief methods and fields of application and lists many proved present day uses. Many illustrations are used to make all the important parts of the text easily understood and several types of High Frequency Generators are shown. Scientific Electric.

11 **Load-Center Unit Substations**—Bulletin GEA-3592 explains how the load-center power system avoids freezing of machine locations; shows typical installations in many plants; gives helpful data on planning fully modern power flow systems. General Electric Co.

12 **Ceramic Insulators for Electrical Uses**—Bulletin No. 444, published by the American Lava Corporation, will prove a valuable tool in the hands of engineers, designers and research men. AlSiMag ceramic insulator bodies, each with its physical and electrical characteristics, are concisely described and uses indicated. Typical designs taken from a roster of more than 25,000 items are illustrated—in applications covering electrical, electronic, industrial heating, chemical, automotive and other fields.

FANS, PUMPS, COMPRESSORS

13 **Vertical Type Pumps**—Bulletin No. 44-4620 tells about construction and application of Byron Jackson VMT pumps. Designed for handling liquids—hot or cold—where the net positive suction head is limited. Byron Jackson Co.

14 **Centrifugal Pump Handbook**—"Self-Priming Centrifugal Pumps," sets forth in easy-to-understand style, principles of centrifugal action, physics of pumping, evolution of self-priming centrifugal pumps. Besides giving basic engineering information, the handbook tells the difference between the types of self-priming centrifugals, points out where self-primers can be used with best effect, explains how to install and care for them. Marlow Pumps.

15 **Gas-Engine Compressors**—Worthington Pump & Machinery Corp, 24 pg bulletin No. L-685-B1 gives engineering details of LFC angle four-cycle gas-engine compressors for gas or air lifting, refrigeration, repressuring, general air supply.

16 **Pumping Unit For Centralized Lubrication**—Bulletin No. 40 describes the Farval automatic central pumping Unit DC-25. This is a small size, double plunger, slide valve unit which provides a positive high pressure pump for the handling of all types of lubricants without the use of springs, check valves or stuffing boxes. The complete system will handle either oil or grease and requires no attention except the renewal of the lubricant supply in the reservoir. Farval Corp.

17 **Steam Heat Vacuum Pump**—Specifications, sizes and capacities of Warren steam heat vacuum pumps are given in new Bulletin 226-1. Rigidly supported valve gear may be adjusted while pump is in operation. Warren Steam Pump Co.

18 **Steam-Jet Ejector Data**—A New Bulletin 9013 covers steam-jet ejectors, should be of interest to all industries having need for vacuum-producing equipment. Some uses include: vacuum packing, deaerating of soap, clay, etc., and producing simulated altitude conditions for testing engines, pumps, instruments, etc. Operating characteristics, principles, and features are given, as well as construction details and schematic diagrams of various single and multi-stage set-ups. Ingersoll-Rand Co.

INSTRUMENTS AND CONTROLS

19 **Steam And Liquid Control**—New 40 pg Keckley Catalog describes precision pressure regulating valves, pump governors, temperature regulators, relief valves, float valves and other control equipment. O. C. Keckley Co.

20 **Insulation Tester**—The new U. S.-made "Megger" insulation tester, in plastic molded case, and said to have the same ruggedness and accuracy common to all "Megger" instruments, is described in new Bulletin 1735-PE. James G. Biddle Co.

21 **New Air Control For Pumps**—Bulletin describing applications of a new simple, air control for shallow well pumps has been issued by Manning, Maxwell & Moore, Inc. Features include rubber diaphragm as the single moving part which combines valve head, gland seal, and float hinge. Valve has stainless steel orifice and is completely sealed. It has no water cavities. Control is for applications up to 80 lb. psi tank pressure.

22 **Steam Pressure Control** — Bulletin C1 tells about the accuracy, flexibility and compactness of the Fisher Type 92 automatic controller for steam pressure regulation. Ten sizes. Fisher Governor Co.

23 **Electronic Resistance Thermometers** —Bailey Meter Co. Bulletin No. 230-A features Bailey pyrotron electronic resistance thermometers in indicating, recording and controlling models, for temperature ranges between the limits of minus 100 deg. F. and plus 1200 deg. F. Describes the electronic detector and motor control; gives information on: ranges, power supply required, speed of response, accuracy, sensitivity, installation, standard chart ranges, automatic control application, etc.

MECHANICAL TRANSMISSION

24 **New Catalog On Couplings**—A new, 8-pg, illustrated Book No. 2045 on a complete line of shaft couplings, is announced by Link-Belt Co. Sizes, dimensions and list prices are given for couplings of flexible, rigid flanged face and compression types, with special emphasis on the Type "RC" Roller Chain Coupling. Detailed information is also given on protective casings for the "RC" coupling. This includes two styles of revolving casings ("R" and "P") and a type "S" stationary-mounted casing.

25 **Fractional HP V-Belts**—New handy conversion chart and price list for fractional horsepower V-belts has just been issued by The B. F. Goodrich Co. It gives the size and conversion data on standard "O," "A," and "B" section belts for refrigerators, washing machines, ironers, stokers, oil burners, pumps, wood working machines, compressors, grinders, blowers, and industrial machinery.

26 **Belting Reference Chart**—New transmission and conveyor belting chart provides a rapid reference for standard belt thicknesses and includes full information as to fastener and lacing sizes for each thickness. All commonly used belting materials are covered—leather, cotton woven, canvas and balata, rubber, etc. Baldwin Belting, Inc.

27 **Spiral-Bevel Speed Reducers** — Bulletin 200 gives design features, hints on selecting proper units, table of load characteristics, horsepower ratings and other helpful handbook data on Philadelphia spiral-bevel speed reducers. Also pictures typical installations. Philadelphia Gear Works, Inc.

PIPING, VALVES AND FITTINGS

28 **Steam Line Corrosion Treatment**—Illustrated folder explains how Saverite steam line corrosion treatment is applied and how it dissolves scale, rust and other elements in pipes. Saverite Engineering Co.

29 **Non-Return Valves**—Catalog 12-B describes Edward non-return valves, cast and forged steel in 300 to 2500 lb sp classes. Full dimensions, cross-section illustrations and descriptions. Maintenance hints, pressure drop data, pressure-temperature tables and other useful information. Every power station operator should have this helpful new catalog. Edward Valve & Mfg. Co., Inc.

Coupon must be filled in completely to secure literature you request. Pasting coupon on penny postcard saves time and money.

APRIL, 1945

POWER PLANT ENGINEERING
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Chicago 4, Illinois

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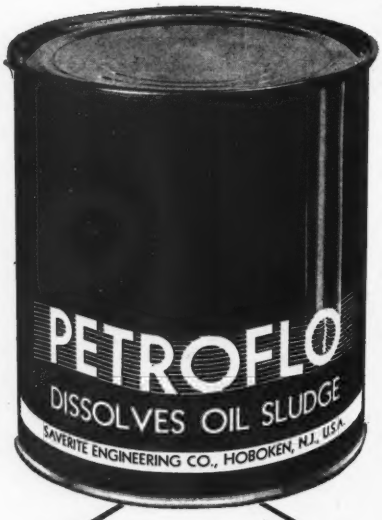

Cleans
FUEL SYSTEM

Improves
COMBUSTION

All grades of fuel oil contain carbon ends and impurities. Minute clusters of these combine and settle to the bottom of the tank as sludge. This sludge builds up until it reaches the feeder pipe leading to the burner tip, decreasing efficiency and, sometimes, causing shutdowns and expensive repairs.

Sludge removal by manual or mechanical methods is costly and time-consuming, especially in underground tanks. By adding 1 lb. Petroflo to each 1000 gals. (23 bbls.) while the fuel is pumped into the tank, sludge-forming carbon ends and impurities are maintained in suspension, assuring a steady, free flow of oil, which results in better atomization, and produces a soft, even, efficient flame.

Petroflo also dissolves sludge already in the tanks and fuel system, and keeps them clean. The cost of Petroflo is insignificant, considering the many benefits it offers.

Petroflo is stocked at convenient shipping points. Send us a sample order.

XZIT SALES COMPANY

Factories at

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5800 S. Hoover St., LOS ANGELES 44, CAL.

30 **How To Choose A Steam Trap**—Answers to questions such as: where should steam traps be placed, how should they be sized and selected, will be found in the book "How To Choose A Steam Trap". V. D. Anderson Co.

31 **Steam Hook-Up Book**—Many practical ideas on how to enlarge the capacity of steam heating lines and heating coils will be found in the Sarco Hook-Up book. Contains recommendations and sketches for fitting Sarco traps, strainers and other products into your plant operation. Sarco Co., Inc.

32 **Heat Insulation Handbook** — 176-pg Heat Insulation Handbook describes Ehret's 85% magnesia and other heat insulating materials, both as to selection and application for boilers, steam lines, tanks, etc. Ehret Magnesia Mfg. Co.

33 **Tube Cleaning Suggestions**—Correct steps in a tube-cleaning operation to insure highest efficiency are outlined in a new service bulletin by Thomas C. Wilson, Inc. Information covers selection of appropriate equipment, proper cleaning procedure, care of cleaning equipment, and listings of types and sizes of motors, cutters, brushes and other accessories required.

WATER TREATMENT

34 **Double-Check Zeolite Softener**—Elgin Softener Corp. in Bulletin 606, describes an improved water softener which, compared to others of equal size, is said to give up to 44 per cent more soft water. Equipped with new manifold arrangement which prevents loss of zeolite.

35 **Scientific Water Conditioning**—Bulletin covers Bird-Archer line of water testing equipment, conductivity apparatus, proportioning pumps and chemical feeds. Describes "Tanalginate," an organic colloid of reactive and protective type for treatment of boiler water. Eliminates baked sludge, permits increased boiler water concentrations, reduces blow-down. Bird-Archer Co.

36 **Industrial Cleaning Service**—Bulletin tells about the development of Dowell chemical method for removing water- or steam-deposited sludge and scale from all types of industrial equipment. Lists actual results of this cleaning service in boilers, condensers, water lines, economizers, distillery, blast furnace. Contains typical hookup diagram. Dowell, Inc.

37 **Water Deaeration Halts Corrosion**—Reprint 36 describes the application and general design of cold water deaerators to prevent corrosion of pipe lines, heat exchange equipment, etc. This type deaerator will have wide application in industrial plants, utilizing large quantities of cooling water. Cochrane Corp.

MISCELLANEOUS

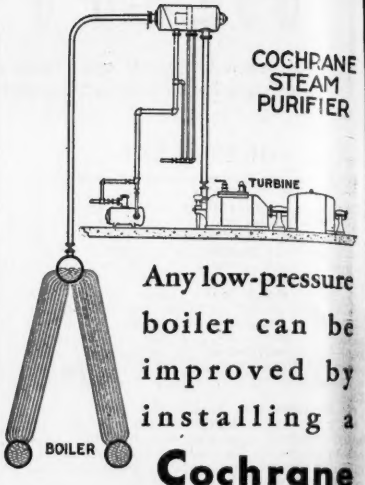
38 **Packing Ring Cutter**—Master mechanics and engineers will find the Zim cutter very handy for cutting rings to accurate sizes from any coil or spiral packings. Easy to operate, cuts any pliable material, has eight adjustable cutting arcs. Zimmerman Packing Co.

39 **Plant Maintenance Handbook**—New, informative 20 pg Digest On Modern Power Plant Procedures gives tips on up-to-the-minute techniques for handling cleaning, de-rusting, paint stripping and other power plant maintenance tasks. Among the 71 different maintenance jobs concisely described are cleaning and descaling heat exchange equipment and cooling systems; boiler room equipment; salvaging fittings, valves, pumps, etc.; Oakite Products, Inc.

40 **Welder's Guide On Hard Facing**—Practical methods of welding a hard wear-resistant metal to surface of softer metal are described in latest edition of Welder's Guide To Successful Hard Surfacing. Also lists many types of industrial equipment on which hard facing applications are used. Mir-O-Col Alloy Co.

41 **Free Repair Handbook**—Company offers free protractor-rule and 40-page guide for the use of Smooth-On cements, containing 170 diagrams and instructions for making lasting and economical repairs to plant equipment and machinery, pipe lines, fixtures, etc. Smooth-On Mfg. Co.

42 **Acetylene Generator Bulletin**—Bulletin features the new Airco Type "P" portable acetylene generator, incorporating an "air lift" water circulating system and enlarged radiation space between the carbide hopper and water level which eliminate the "hot belt" and provide cooler, double-scrubbed gas. Also illustrates the company's complete line of generators.



Any low-pressure boiler can be improved by installing a

Cochrane

PURIFIER

How to get greater capacity from low-pressure boilers is the problem that confronts operators in many power plants all over this country. For many years the Cochrane Purifier has been one answer to this particular problem. In some instances boiler output has been practically doubled after installing Cochrane Steam Purifiers or Receiver Separators. For example:

A large industrial plant in Indiana needed more boiler capacity quickly, but 400 h.p. was the maximum load that could be carried on the 250 h.p. boiler without danger from slugs of water. After installation the owner writes: "We are now carrying 700 h.p. on the boiler whereas before installing the Cochrane Purifier we were able to carry only 400 h.p. without carry-over."

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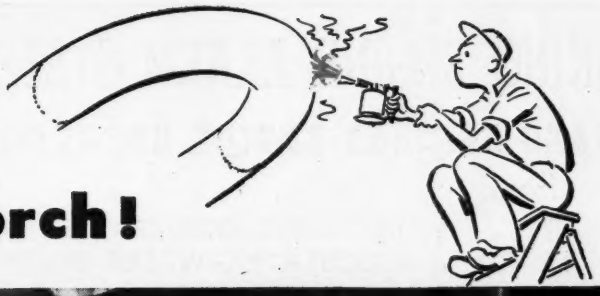

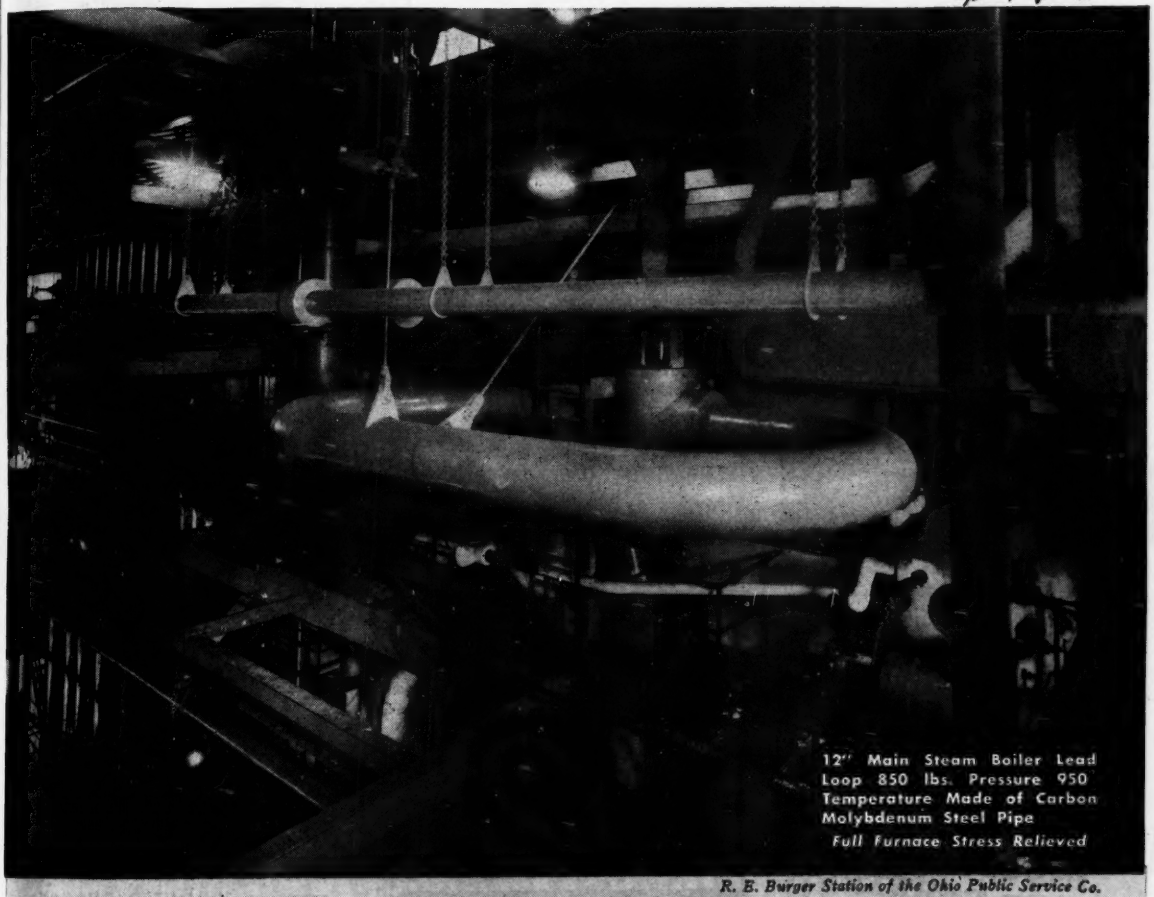

12" Main Steam Boiler Lead Loop 850 lbs. Pressure 950 Temperature Made of Carbon Molybdenum Steel Pipe
Full Furnace Stress Relieved

R. E. Burger Station of the Ohio Public Service Co.

Trying to stress-relieve this main steam boiler lead loop with a blow torch in the field would be ridiculous.

Grinnell provides the specialized shop equipment to handle this class of work. Grinnell engineers and technicians have resourceful "know-how" gained from long experience. By continuous laboratory research and experimentation they are developing new processes and techniques for the prefabrication of piping for higher pressures, higher temperatures and corrosive services.

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Every diesel and gas engine should be properly protected with a Viking alarm system. Viking is a *complete system*, no extras to buy. When water temperature becomes too high or oil-pressure too low, howler sounds to warn operator of danger. Type M-3B provides visual indication of source of trouble, also Heavy-duty construction, factory-set for your own requirements.

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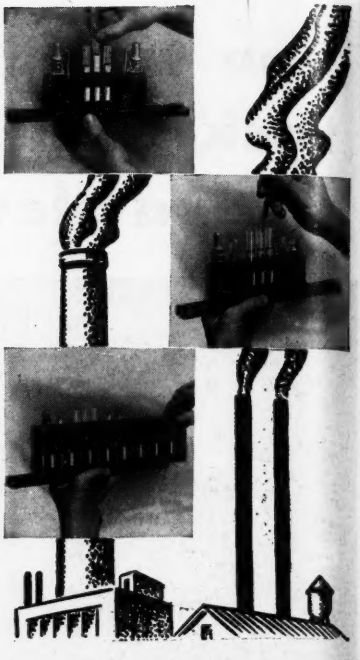

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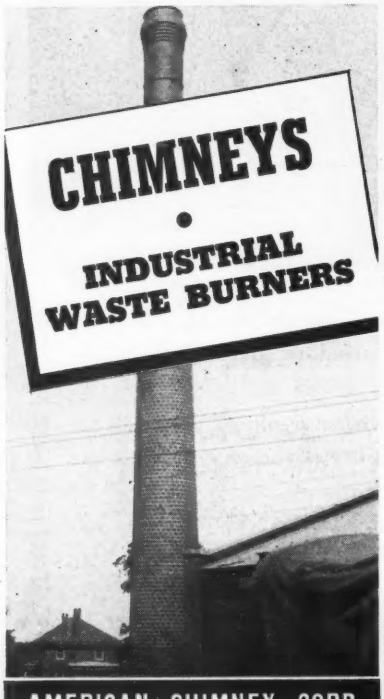

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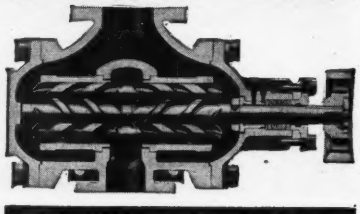

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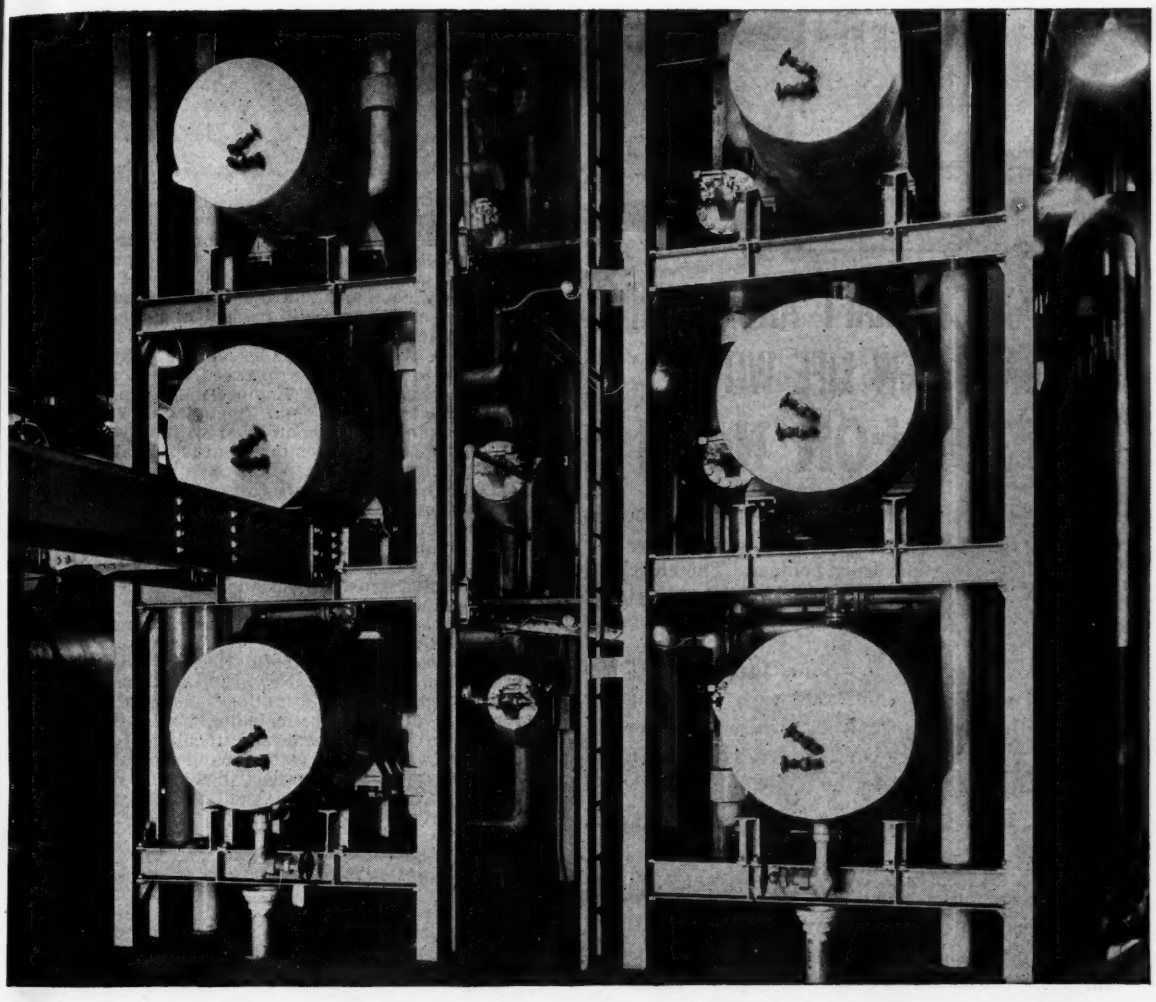

Huntley Station Equipped with ALCO High-Pressure Feedwater Heaters

Buffalo Niagara Electric Corporation plant-installation shows interesting features

THIS PHOTOGRAPH, showing shell-cover end of six ALCO High-Pressure Feedwater Heaters installed in Huntley Station of Buffalo Niagara Electric Corporation, gives emphasis to several unusual features.

Outstanding is the fact that the heaters are stacked three high and that the shells are fitted with rollers.

This installation is further evidence of the trend toward ALCO heaters in high-pressure steam-plant practice. Several ALCO installations are operating successfully at 2200 lbs. pressure.

ALCO Bulletins describing and illustrating this equipment will be sent promptly on request. You are cordially invited to consult ALCO engineering specialists in connection with any feedwater-heater and heat-exchanger problem.

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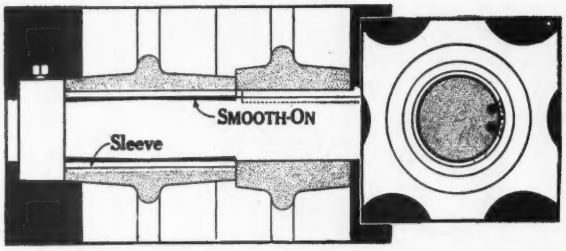

WORN PULLEY SHAFT AND BEARING GIVEN NEW LIFE WITH SMOOTH-ON No. 1

A 2 1/16" pulley shaft in a Southern mill had worn to 2 3/8" at one edge and 2 1/2" at the other. The inside bearing had worn conical. The clutch would no longer hold and the shaft constantly overheated.

A sleeve of extra heavy pipe, turned to 2 3/4" O.D. was screwed around the worn shaft, just touching the high spots. The worn sections were filled in with Smooth-On No. 1. The bearing was bored and bushed to the new 2 3/4" diameter.

Next morning the shaft went back into continuous service.

Engineers and maintenance men in industrial and power plants the country over are constantly finding just such ingenious uses for Smooth-On No. 1 . . . the half-century-old repair standby . . . as well as depending on it for routine repairs. Easy to use—requires no heat. Makes lasting repairs at low cost. Get Smooth-On No. 1 at your supply house in 7-oz. and larger containers.

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POWER PLANT *Construction News*

Ark., North Little Rock—Arkansas Power & Light Co., Pine Bluff, Ark., has plans under way for new outdoor-type steam-electric generating station at Rose City, near North Little Rock, with installation to include high-pressure boilers, generating units with capacity of 130,000-kw., and auxiliary equipment. Project will include transmission line for connection with present high-tension system, switching station and other facilities. Cost reported close to $3,000,000. Application has been made to State Utilities Commission for authority to proceed with project.

Calif., Azusa—Aerojet Engineering Corp., 285 West Colorado St., Pasadena, Calif., manufacturer of jet propulsion equipment, has contracted with Government for new plant at Azusa, consisting of group of about 15 one-story buildings. Electric power equipment will be installed. Entire project will cost about $1,000,000, with financing provided by Defense Plant Corp., Washington, D. C., Federal agency. Work will begin soon.

Calif., Imperial—Imperial Irrigation District, Imperial, is arranging a postwar expansion program for line construction, including extensions and improvements in transmission and distributing lines, with power substations, service connections and other operating facilities. Cost estimated close to $1,000,000.

Conn., Cos Cob—New York, New Haven & Hartford Railroad Co., Water St., New Haven, Conn., has plans nearing completion for alterations and improvements in power plant at Cos Cob, including installation of additional electrical equipment and facilities for increased capacity. Also will make extensions in a number of power substations at points along electrified route, with installation of capacitators and other equipment. Entire program is reported to cost over $500,000. Gibbs & Hill, 470 Seventh Ave., New York, N. Y., are consulting engineers.

Ill., Chicago—Columbia Malting Co., 141 West Jackson Blvd., plans installation of electric power equipment in new addition to malt plant at Indianapolis Blvd. and 105th St. Cost estimated close to $200,000. Application has been made for a priority rating. Bids are scheduled to be asked soon.

Ill., Macomb—Board of Directors, Western Illinois State Teachers' College, Macomb, is considering a postwar expansion and improvement program at institution, including addition to power plant and installation of additional equipment for increased capacity. Cost estimated close to $500,000.

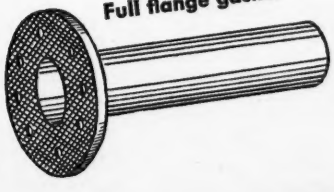
Ill., Ottawa—Inland Rubber Corp., 33 South Clark St., Chicago, Ill., is completing plans and will soon begin erection of new plant at Ottawa for manufacture of heavy-duty tires for military trucks and vehicles. It will comprise several one and multi-story buildings, equipped for large capacity. Electric power equipment will be installed. A boiler house is planned. Cost about $7,000,000, with financing provided by Defense Plant Corp., Washington, D. C., Federal agency, Giffels & Vallet, Inc., Marquette Bldg., Detroit, Mich., is architect and engineer.

Ind., Frankfort—Swift & Co., Packers Bldg., Chicago, Ill., meat products, processed foods, etc., have plans maturing for new soybean processing mill at Frankfort, comprising group of seven one and multi-story buildings, with machinery installation for large output. Electric power equipment will be installed. A boiler house will be built. Entire project will cost over $450,000.

Ind., Lawrenceburg—J. E. Seagram & Sons Co., has plans under way for new power plant at local whiskey distillery, reported to cost close to $90,000 with equipment. It is understood that project will have a priority rating. Smith, Hinchman & Grylls, Marquette Bldg., Detroit, Mich., are engineers. Work is scheduled to begin soon.

Kan., Coffeyville—Light and Water Department, City Bldg., has plans in progress for extensions and improvements in municipal light and power plant, to be carried out as a postwar project. Work will include installation of new 10,000-kva. turbine-generator unit and accessories, high-pressure boilers, cooling tower and auxiliary equipment. Cost reported close to $1,400,000. Black & Veatch, 4706 Broadway, Kansas City, Mo., are consulting engineers.

How to Seal Pipe Flanges...



A *ring cut* gasket, properly applied, does a better job than a *full flange* gasket. Here are a few hints that will help:

1. Make sure flanges are perfectly clean and true.

2. Use as thin a gasket as possible for the particular flange condition. (The rougher the flange surfaces, the thicker the gasket needed.)

3. See that the gasket is properly centered and does not project inside the flanges.

4. Pull up the flanges evenly and tightly, alternating from side to side to insure even pressure all around.

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Kan., Kansas City—Lee Rubber & Tire Co., Conshohocken, Pa., has concluded contract with Government for construction and operation of new plant at Kansas City for manufacture of heavy-duty truck tries for military vehicles. It will consist of a main one-story building 330 x 900 ft., and auxiliary units, to be equipped for large capacity. Electric power equipment will be installed. A boiler house and compressor plant will be built. Entire program will cost about $4,000,000, and will be financed by Defense Plant Corp., Washington, D. C. Albert Kahn, Inc., New Center Bldg., Detroit, Mich., is architect and engineer.

Mich., Detroit—De Soto Division, Chrysler Corp., 6000 Wyoming Avenue, now in production for gun mounts and other war products for Government, will carry out expansion in plant, consisting of additional buildings for parts production and assembling. Electric power equipment will be installed. Entire project will cost about $881,500, with financing provided by Defense Plant Corp., Washington, D. C., Federal agency.

Mo., Poplar Bluff—Missouri Utilities Co., has plans for new addition, about 42 x 114 ft., to local steam-electric generating station, for expansion in turbine and boiler department, respectively. Additional equipment will be installed for increased capacity. No estimate of cost announced. It is understood that project will have a priority rating. Black & Veatch, 4706 Broadway, Kansas City, Mo., are consulting engineers.

Neb., Lincoln—Water and Light Department, Lincoln, has plans for new cooling tower at municipal steam-electric generating station at 39th and A Sts. Project has a priority rating. A call for bids has been authorized. No estimate of cost announced.

N. Y., Camp Upton—District Office, U. S. Corps of Engineers, 120 Wall St., New York, N. Y., will prepare plans for extensions and improvements in boiler plant at Camp Upton, used for central-heating service, with installation of additional equipment for increased capacity. This is part of an expansion and improvement program to be carried out at that place at total estimated cost of $1,327,000.

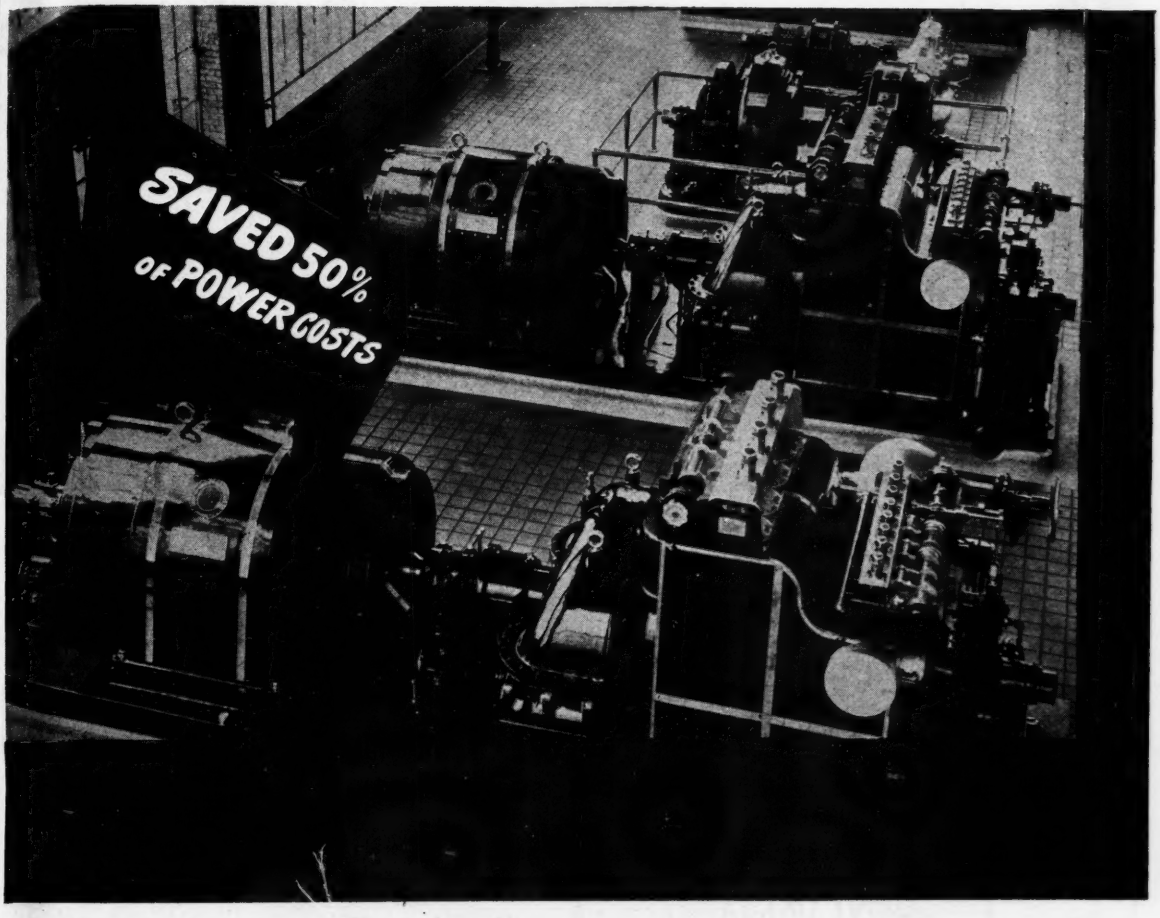
Ohio, Mansfield—Mansfield Tire & Rubber Co., plans installation of electric power equipment in connection with expansion in plant for manufacture of heavy-duty tires for military trucks and vehicles, consisting of several additional buildings, with machinery for large output. Cost estimated at $1,750,000, with financing provided by Defense Plant Corp., Washington, D. C., Federal agency. Work will begin soon.

Ohio, Springfield—Board of Trustees, Oesterlen Orphan Home, Springfield, has authorized plans for new boiler plant at institution for central-heating service, estimated to cost about $100,000, with boilers, pumps and auxiliary equipment. Application will be made for a priority rating. Ralph Harmon, Columbia Bldg., Springfield, is architect.

Ore., Roseburg—California-Oregon Power Co., Medford, Ore., has preliminary plans for new hydroelectric power plant on North Umpqua River, Roseburg. Project will include a power dam at Toketee Falls, 7500-ft. tunnel to mouth of Glide Creek for water diversion and hydroelectric station, with hydraulic turbines and electric generators of 53,600-hp., gross rating, operating under head of 415 ft. Also transmission line, about 40 miles long, with switching station and other facilities. Entire project is estimated to cost approximately $4,000,000. Application for permission has been made to Federal Power Commission, Washington, D. C.

Tenn., Fountain City—Knox County Water Co., Fountain City, plans new water filtration plant at supply source on Beaver Creek, including a 500,000-gal. steel reservoir. Cost estimated about $160,000. Project will be carried out as a postwar development. Wiedeman & Singleton, C. & S. National Bank Bldg., Atlanta, Ga., are consulting engineers.

Texas, Dallas—Standard Brands, Inc., 409 Latimer St., manufacturer of food products, plans installation of electric power equipment in new two-story plant on local site at 2306 Amelia St., estimated to cost about $2,000,000. Project will have a priority rating and work will be placed under way soon. Thomas, Jemison & Merrell, Construction Bldg., Dallas, are architects. Main offices are at 595 Madison Ave., New York, N. Y.



Power costs have gone down 50% in the Ford Motor Company's Chicago power plant near the Calumet River. This is another example of how *modern* automatic extraction type turbines can cut power costs, far below costs of older methods of power generation. Superintendent reports "excellent service record during the period since installation with no interruption."

Engineered to Fit the Job

Taking 225 lb. 525° steam at the throttle, the Worthington-Moore turbines exhaust to the condensers, and automatically extract steam at 5 lbs. pressure to satisfy variable process and heating steam requirements.

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In many other turbine-generator installations, firms like yours have profited from Worthington's broad experience with steam power plant equipment, plus Moore's years of turbine engineering and manufacture. Write us, or call our nearest district office. *Worthington Pump and Machinery Corporation, Moore Steam Turbine Division, Wellsville, N.Y.*

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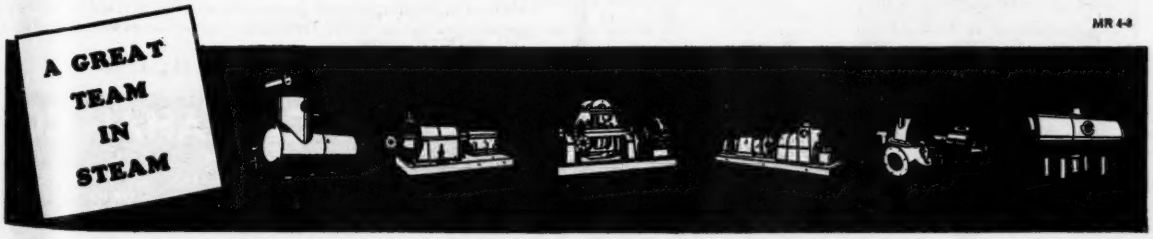

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It is extensively used by institutions, industrial plants and process industries to measure the steam consumption of separate buildings, departments or processes—condensate from steam consuming equipment and heating systems—for any application where a knowledge of steam consumption is essential to economical operation.

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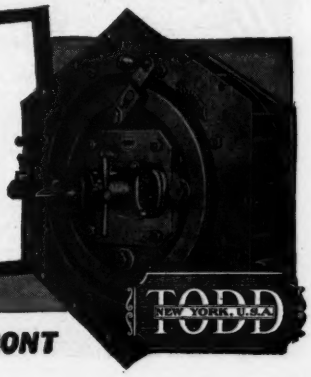

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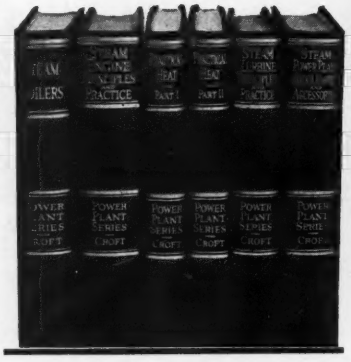

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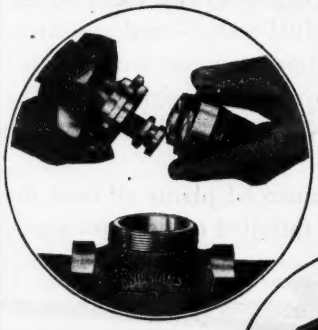

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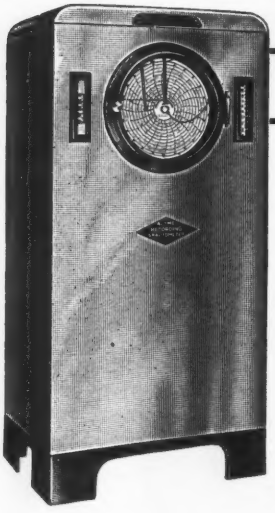

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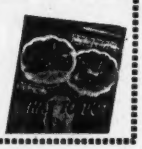

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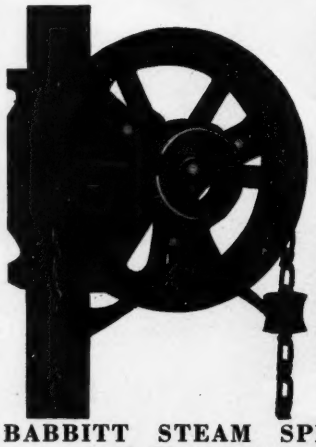

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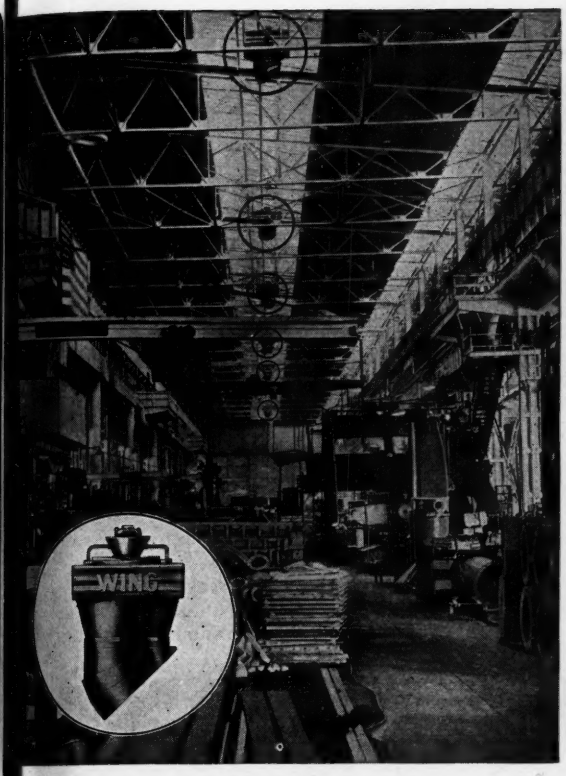

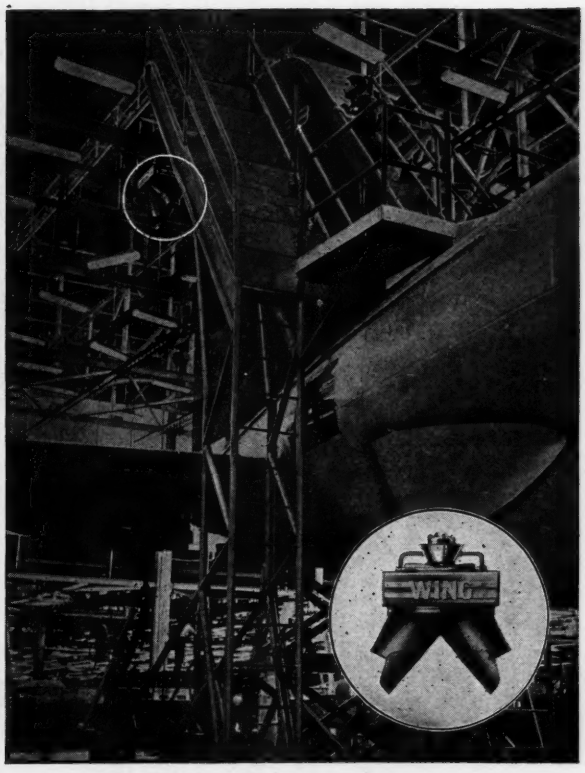

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Help Keep Shipbuilders (Sea and Air) on the Job

Two striking instances of the virtues of Wing Revolving Unit Heaters are exemplified in the photographs above.

At the left is one of the shops of a large shipbuilding concern, where the Wing Revolving Heaters are located 61 feet above the shop floor. Yet the heated air is projected down to the working level and circulated by the slowly revolving outlets of the heater so that every part of this huge shop (802 ft. x 156 ft.) is kept warm and comfortable, protecting the health of workers and keeping vital shipbuilding production moving.

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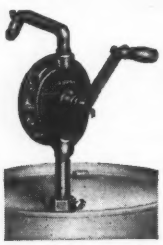

The "Bucket Design" swinging vanes automatically compensate for wear. When the "buckets" finally wear out, a simple replacement job restores the pump to normal capacity.

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Write for Bulletin No. 306 — Facts About Rotary Pumps

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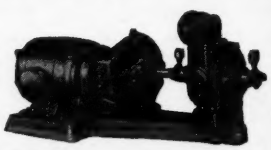

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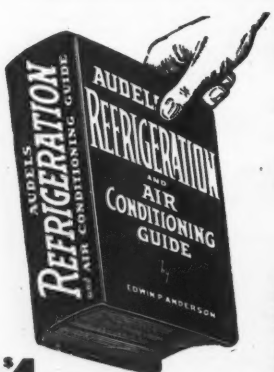

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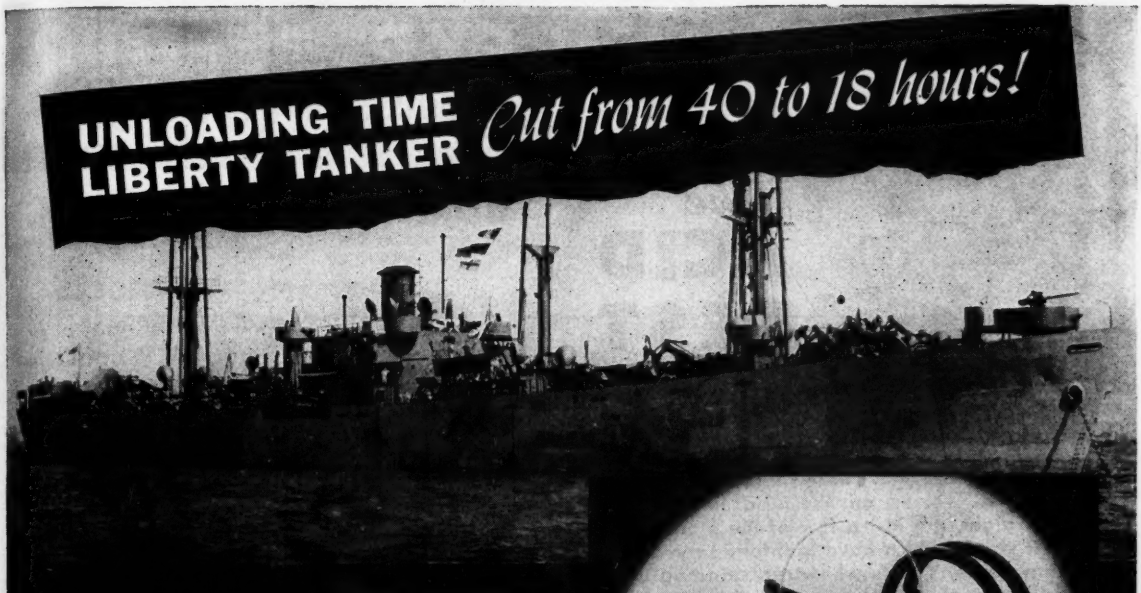

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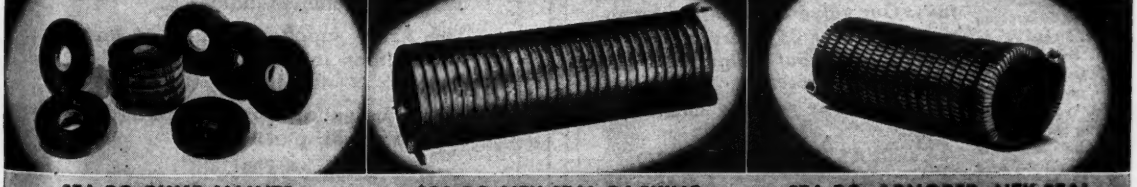

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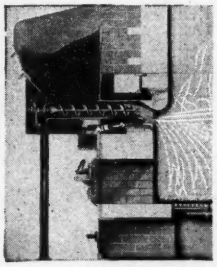

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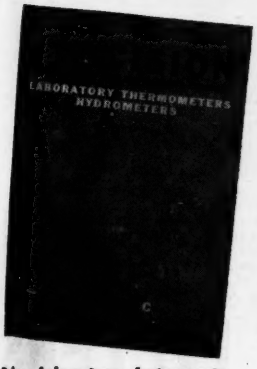
Under separate cover we are sending you PRINCO Catalogs as requested . . .



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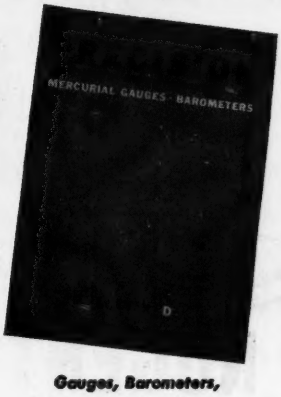

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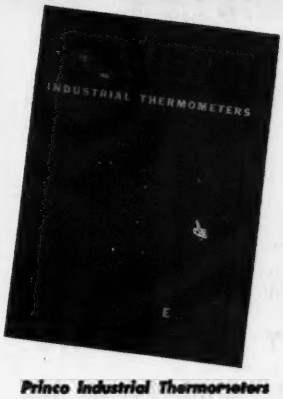

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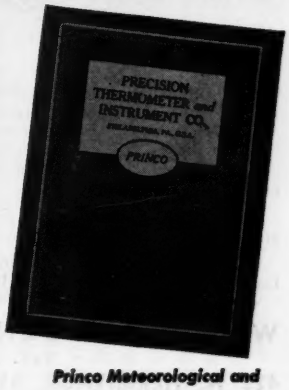

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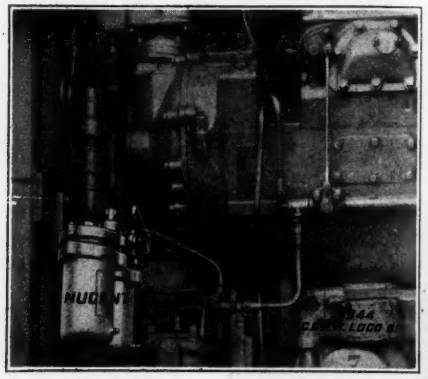

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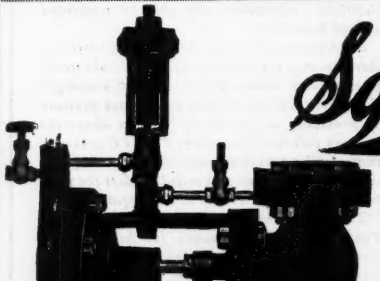

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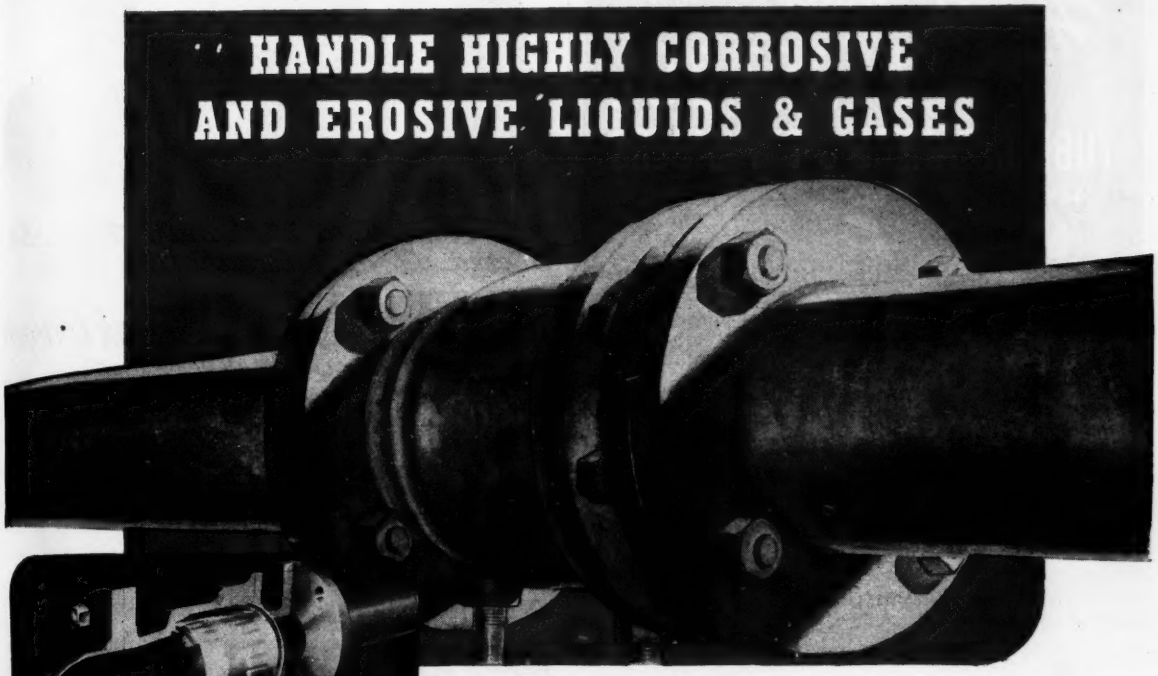

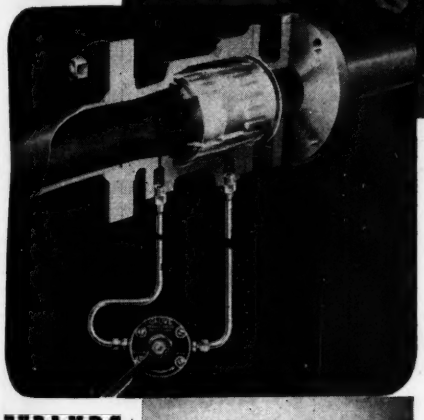

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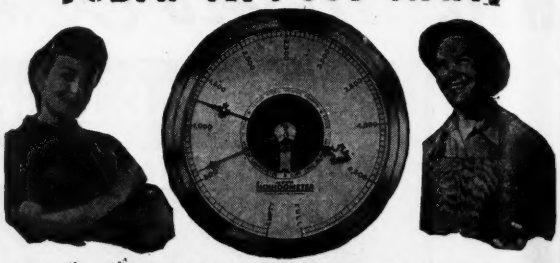

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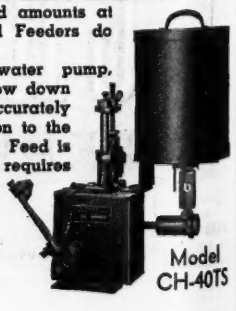

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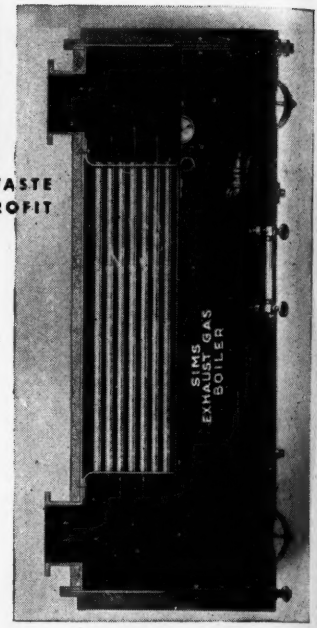

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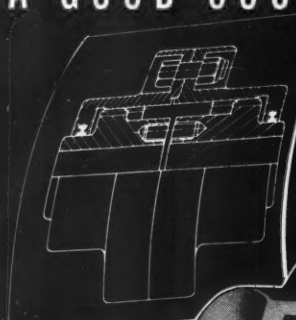

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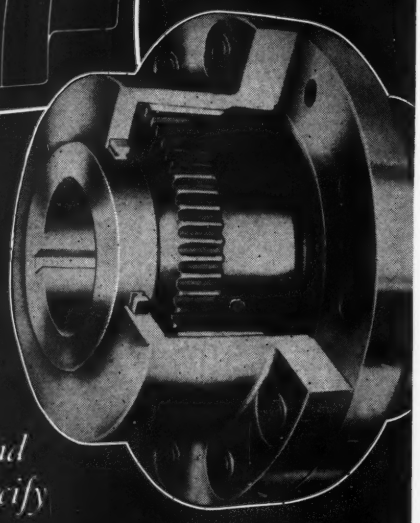

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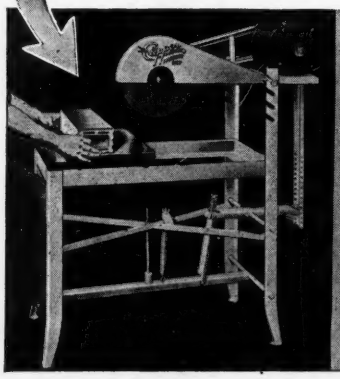

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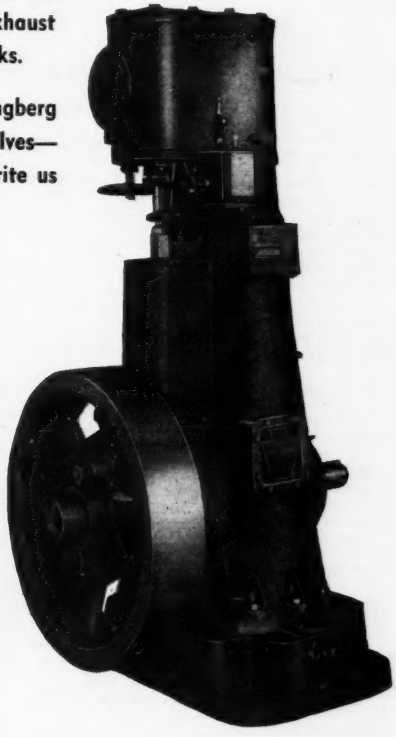

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